Environmental Consequences

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ENVIRONMENTAL CONSEQUENCES

INTRODUCTION

This "Environmental Consequences" chapter analyzes both beneficial and adverse impacts that could result from implementing any of the alternatives described in this final elk and vegetation management plan and environmental impact statement (plan/EIS). This chapter includes a summary of laws and policies relevant to each impact topic, definitions of impact thresholds (negligible, minor, moderate, and major), methods used to analyze impacts, and the analysis methods used for determining cumulative effects. As required by the Council on Environmental Quality (CEQ), regulations implementing the National Environmental Policy Act (NEPA), a summary of the environmental consequences of each alternative is provided in Table 2.2 in the "Alternatives" chapter. The resource topics presented in this chapter and the organization of the topics correspond to the resource discussions contained in the "Affected Environment" chapter.

Summary of Laws and Policies

Three overarching environmental protection laws and policies guide the actions of the National Park Service (NPS) in the management of the park and its resources: the NPS Organic Act of 1916, NEPA and its implementing regulations, and the Omnibus Management Act. For a complete discussion of these and other guiding regulations, refer to the section "Laws, Regulations, and Policies" in the "Purpose of and Need for Action" chapter. Collectively, these guiding regulations provide a framework and process for evaluating the impacts of the alternatives proposed in this plan/EIS.

General Methodology for Establishing Impact Thresholds and Measuring Effects by Resource

The general approach for establishing impact thresholds and measuring the effects of the alternatives on each resource category includes the following elements:

- General analysis methods as described in guiding regulations
- Basic assumptions used to formulate the specific methods used in this analysis
- Thresholds used to define the level of impact resulting from each alternative
- Methods used to evaluate the cumulative impacts of each alternative in combination with unrelated factors or actions affecting park resources
- Methods and thresholds used to determine if impairment of specific resources would occur under any alternative

These elements are described in the following sections.

General Analysis Methods

The analysis of impacts follows CEQ guidelines and *Director's Order 12* procedures (NPS 2001c).

Extensive research has been conducted on the elk population and the condition of vegetation within the elk range in Rocky Mountain National Park. Researchers have also studied effects of elk and vegetation management on visitors and regional social and economic conditions within the park and within the Estes Valley. There is also extensive secondary research that relates elk and elk management to the environmental effects on other natural, social, and economic resources.

There are a number of agencies, universities, and other NPS units that have expertise and experience in or responsibilities for managing elk and wildlife populations and have extensive knowledge of the success of management methods. The internal EIS team consulted with these experts in the field of wildlife and vegetation management, as well as other experts in the resource management and the scientific communities, for the various resource topics addressed in this plan/EIS. Where conclusions are drawn without specific reference to the scientific literature, these are based on based best professional judgment gathered in EIS team workshops and through team consensus.

Alternative 2 and Alternative 3, the preferred alternative, involve the potential use of wolves as an adaptive management method to facilitate redistribution of elk if opportunities were present to cooperate with adjacent land managers and the State of Colorado and if supported by state and federal policy. If based on monitoring the park determines that other redistribution methods conducted by NPS staff or contractors are not effectively meeting management objectives for the recovery of vegetation, wolves may be released in the park according to the process detailed in Alternative 5. The analysis presented for Alternative 2 and Alternative 3 describes the impacts of specific elements under each alternative. For the impacts of the adaptive use of wolves under Alternative 2 and Alternative 3, the reader is referred to the Alternative 5 analysis.

Alternative 3, the preferred alternative, also includes the adaptive use of fertility control agents to manage the elk population size. If during the planning period a multi-year fertility control agent becomes available that is logistically feasible for the treatment of a free-ranging elk herd, the National Park Service could consider use of the agent to reduce and/or maintain the elk population size. For the impacts of the adaptive use of fertility control agent under Alternative 3, the reader is referred to the Alternative 4 analysis.

Alternative 3 would also involve the adaptive use of a capture facility if it is believed that it would increase effectiveness and efficiency of the lethal removal or fertility control. The effects of a capture facility would be the same as described in Alternative 2 and the reader is referred to that alternative analysis for a discussion of impacts.

For each resource topic addressed in this chapter, the applicable analysis methods are discussed under each resource section.

Assumptions

Several guiding assumptions were made to provide context for this analysis. These assumptions are described below.

Analysis Period

This plan/EIS establishes goals, objectives, and implementation actions needed to manage elk and vegetation in the park for the next 20 years.

Geographic Extent of Impact

Unless specified otherwise, the impact analysis area includes the elk primary winter and summer ranges within Rocky Mountain National Park and the Estes Valley. The terms used to define the extent of a particular effect or impact include the following:

Local effects of an action would affect the elk population within relatively small areas within the park, such as a particular valley, drainage, or stand of vegetation.

Range-wide effects would occur over all or most of the elk primary winter and summer ranges, including areas inside and outside the park.

Park-wide effects would affect resources within Rocky Mountain National Park.

Regional effects could occur over the entire park and extend to areas outside the park.

Assumptions about Elk Population, Distribution, and Behavior, and about Effects of Management Actions

The following general assumptions were used to analyze the effects of elk and vegetation management actions on elk population, distribution, and behavior.

The elk subpopulation in the park is relatively stable. Recent observations suggest that the elk subpopulation outside the park could be stabilizing, but this has coincided with dry weather conditions and alterations in migration patterns. Thus the stability in elk numbers outside the park or changes in habitat use may not be a long-term trend and this subpopulation could potentially increase. With a continuation of current management, there would be no change in the number or density of elk over time in the park. It is predicted that the total Rocky Mountain National Park / Estes Valley elk population would continue to fluctuate between 2,200 and 3,100.

Elk population reduction actions taken inside the park between November and February would result in the removal of elk from the park subpopulation, and those actions taken in September and October and in the summer months would proportionately affect each of the elk subpopulations (i.e., one-third of the elk affected would be from the population that stays in the park year round and two-thirds of the elk affected would be from population that uses habitat outside the park in winter).

In general, lethal reduction actions with suppressed weapons and aversive conditioning actions would be implemented in ways not likely to drive elk out of the park, but would contribute to a redistribution of elk. These actions would result in localized (short-distance) movement of elk. In specific circumstances, such as on the west side during hunting season, aversive conditioning activities and lethal reduction activities with unsuppressed weapons could drive elk to areas open to hunting. Actions may change general elk behavior by instilling greater wariness of humans.

The primary function of wolves in the park would be to redistribute elk. In response to the presence of wolves, elk would be more likely to move into the town of Estes Park. Wolves would prey primarily on elk, but they would not have a large effect in reducing the elk population in the early years of the plan.

To allow full analysis of Alternative 5, it was assumed that the use of wolves would successfully meet objectives and that both phases of the alternative would be implemented. It is further assumed that an increase in the number of wolves in Phase 2 would have greater effectiveness in the redistribution of elk and contribution to reduction in elk population size.

Given that changes in the elk range are unknown and that future changes could occur, it is assumed for purposes of analysis that the extent of the elk range identified in this plan/EIS would not substantially change, barring extreme weather or drought. The elk population would not disperse to areas beyond current bounds of population. There would be little movement of elk to areas such as Loveland.

Assumptions about Vegetation within the Primary Winter and Summer Range

The following general assumptions were used to analyze the effects of elk and vegetation management actions on vegetation within the primary winter and summer elk range.

The effects of elk use on vegetation on the primary winter range are also occurring on the primary summer range; however, the intensity of effect would be less in this portion of the range because the primary summer range is much larger, elk densities are lower, forage availability is higher, and elk spend less time in alpine areas.

With continuation of current management, overgrazing would continue and willow and aspen would be unable to regenerate or recover at the current number and density of elk.

Impact Thresholds

Determining impact thresholds is a key component of the *Management Policies* (NPS 2006b) and the *Director's Order 12 and Handbook* (NPS 2001c). These thresholds provide the reader with an idea of the intensity of a given impact on a specific topic. The impact threshold is determined primarily by comparing the impact to a relevant standard from state or federal regulations or scientific research. Because definitions of intensity vary by impact topic, intensity definitions are provided separately for each impact topic analyzed in this document. The following intensity levels are used throughout this analysis: no effect, negligible, minor, moderate, and major.

Cumulative Effects Analysis Method

The CEQ regulations implementing NEPA require the assessment of cumulative impacts in the decision-making process for federal projects. Cumulative impacts are defined as "the impacts on the environment which result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions" (40 CFR 1508.7). Cumulative impacts are considered for all alternatives, including Alternative 1, which would continue current management practices.

Cumulative impacts were determined by combining the impacts of the alternative being considered with other past, present, and reasonably foreseeable future actions. Therefore, it was necessary to identify other past, ongoing, and reasonably foreseeable future actions within Rocky Mountain National Park and in the surrounding region. A description of other National Park Service and other agency actions and programs is provided in the "Purpose of and Need for Action" chapter under the "Relationship to Other Projects and Plans" section. All past, present,

and reasonably foreseeable future actions that are considered in the environmental analysis include the following:

Trails Management Plan, 1982 – Ongoing

State of Colorado Conservation Strategy for Lynx and Wolverine, 1988 – Ongoing

Vegetation Restoration Management Plan, 2006

Denver International Airport – Thompson Three arrival route, 1996 – Ongoing

Estes Valley Comprehensive Plan, 1996 – Ongoing

Resources Management Plan, 1998 – Ongoing

Greenback Cutthroat Trout Recovery Plan, 1998 – Ongoing

Environmental Assessment for the Management of Snowmobiles in Rocky Mountain National Park, 2002 – Ongoing

Trail System Maintenance and Reconstruction Plan, 2000 – Ongoing

Captive breeding program of boreal toads / Reintroduction into Rocky Mountain National Park, 2001 – Ongoing

Conservation Plan and Agreement for the Management and Recovery of the Southern Rocky Mountain Population of the Boreal Toad (*Bufo boreas boreas*), 2001 – Ongoing

Backcountry and Wilderness Management Plan, 2001 – Ongoing

Wildland-Urban Interface Fuels Management Environmental Assessment, 2003 – Ongoing

Invasive Exotic Plant Management Plan and EA, 2003 – Ongoing

A Strategy for Accelerated Watershed/Vegetation Restoration on the Arapaho and Roosevelt National Forests and Pawnee National Grassland, 2004 – Ongoing

Forest Health and Fuel Reduction Project – Arapaho National Recreation Area, 2004 – Ongoing

Fire Management Plan, 2004 – Ongoing

Bark Beetle Management Plan, 2005 – Ongoing

Colorado State Wolf Management Plan – Future

Transportation Management Plan/EA – Future

Emergency Operations Center – Future

Reroute of the Continental Divide National Scenic Trail – Future

Moraine Park Stables Hay Barn – Future

Highway 7 Corridor Management Plan – Future

Bear Lake Road Reconstruction Phase II – Future

Lawn Lake Restoration Project – Future

Greenback Cutthroat Trout Management Plan – Future

Colorado River Cutthroat Trout Management Plan – Future

Lynx Conservation Agreement and Strategy, 2002 – Ongoing

Arapaho and Roosevelt National Forests and Pawnee National Grassland Revised Land and Resource Management Plan, 1997 – Ongoing

Interim Actions for Chronic Wasting Disease, 2001 – Ongoing

In addition to specific agency actions and programs, other activities would continue within the park and on lands adjacent to the park or in the region that would cumulatively impact resources. Most of these impacts are directly related to growth, land development in the Estes Valley, and

recreational use in the park and in the Estes Valley. Activities associated with management of the park (building construction, resource management and monitoring, and transportation management) also contribute to adverse impacts on resources from loss of habitat, nonpoint source discharges of sediment and nutrients into waterways, and noise emissions.

Impairment Analysis Method

The "Purpose of and Need for Action" chapter describes the related federal acts and policies regarding the prohibition against impairing park resources and values in units of the national park system.

Management Policies Section 1.4.5 states that an action constitutes an impairment when its impacts "harm the integrity of park resources or values, including the opportunities that otherwise would be present for the enjoyment of those resources or values" (NPS 2006b). To determine impairment, the National Park Service must evaluate "the particular resources and values that would be affected; the severity, duration, and timing of the impact; the direct and indirect effects of the impact; and the cumulative effects of the impact in question and other impacts" (NPS 2006b).

Because park units vary based on their enabling legislation, natural resources, cultural resources, and missions, the recreational activities appropriate for each unit and for areas within each unit vary as well. An action appropriate in one unit could impair resources in another unit. Thus, this plan/EIS analyzes the context, duration, and intensity of impacts of the alternatives as well as potential for resource impairment, as required by *Director's Order 12*: *Conservation Planning, Environmental Impact Analysis and Decision-making* and Handbook (NPS 2001c). An impact on any park resource or value may constitute an impairment, but an impact would be more likely to constitute an impairment to the extent that it has a major adverse effect on a resource or value whose conservation is

- Necessary to fulfill specific purposes identified in the establishing legislation or proclamation of the park
- Key to the natural or cultural integrity of the park
- Identified as a goal in a park's general management plan or other relevant NPS planning documents

A determination of impairment is included in the impact analysis section for all impact topics relating to the park's resources and values. The impact analysis includes findings of impairment of park resources for each of the management alternatives. Park management and operations, socioeconomics, and visitor use are not considered park resources; therefore, impairment findings are not included as part of the impact analysis for these topics.

ELK POPULATION

The elk population is one of the park's most notable resources, as the elk population plays a prominent role in the processes that affect many of the park's resources. Elk viewing is one of the primary attractions that draw visitors to the park. Rocky Mountain National Park is responsible for protecting the elk population as a park resource. This section analyzes the potential effects of the proposed alternatives on the Rocky Mountain National Park / Estes Valley elk population.

Summary of Regulations and Policies

The *NPS Organic Act* and *Management Policies* (NPS 2006b) provide the basis for resource protection, conservation, and management and are fully described in Chapter 1, "Purpose and Need."

Director's Order #12 and Handbook: Conservation Planning, Environmental Impact Analysis, and Decision-Making (NPS 2001c) offers the guidance to analyze the potential impacts of the alternatives and to prepare the environmental impact statement.

Rocky Mountain National Park Enabling Legislation states that the park is created "for the preservation of the natural conditions and scenic beauties thereof" (38 Stat. 798). The elk population and its associated vegetation contribute to the natural conditions in the park and are mandated for preservation.

Director's Order #77-4: Use of Pharmaceuticals for Wildlife. This Director's Order and the accompanying Reference Manual #77-4 establish NPS operational policies and procedures for compliance with existing federal laws, regulations, and guidelines governing the use of pharmaceutical agents for wildlife in the National Park System. The administration of pharmaceuticals to wildlife is a necessary component of some management and research activities conducted in the National Park Service. NPS policy is to administer pharmaceuticals to wildlife in a manner that is safe for humans and animals, adheres to humane standards, and is in accordance with NPS wildlife management philosophy.

Methodologies and Assumptions for Analyzing Impacts

Geographic Area Evaluated for Impacts

The geographic area evaluated for impacts on the elk population includes the range of the Rocky Mountain National Park / Estes Valley elk population (see Figure 1.1 in the "Scope of Analysis" section in the "Purpose of and Need for Action" chapter for a more detailed description of the area evaluated in this document). The analyses focus on the primary elk winter and summer range areas, as these are the areas most affected by potential elk management activities and constitute the primary habitats of concern for elk and degraded vegetation in the park. Cumulative effects that would occur both within and outside of these areas were evaluated using the methods described in the "Cumulative Analysis" section.

Issues

Issues that were identified during internal and public scoping regarding elk and vegetation management effects on the elk population include

The elk population size, particularly density and distribution, which can affect vegetation communities and other resources in the park.

The health of the elk population, including survival, mortality, recruitment, body condition, and potential for transmission of chronic wasting disease, may be affected by current management techniques.

The structure of the elk population, including age and sex ratios, may have effects on the long-term viability and ability of the population to stay within the natural range of variation.

The behavior of the elk population during the breeding season (the rut) is important for elk because of the effects on energy expenditures and fitness (i.e., capability of an individual to reproduce).

The elk population exhibits a high degree of habituation to human presence and development, which poses potential for human-elk conflicts.

Elk habitat is being degraded as a result of the high levels of herbivory in some portions of the range.

Assumptions

The following assumptions were used to analyze elk and vegetation management actions on the elk population:

The elk subpopulation in the park is relatively stable.

The elk subpopulation outside the park could potentially increase.

A lack of beaver contributes to changes in hydrology, which contributes to reduced willow cover, resulting in more herbaceous plant cover in riparian areas.

Chronic wasting disease prevalence for elk inside the park is similar to the rate outside the park.

Hunter harvest outside the park is the primary source of elk population reduction. Elk population reduction targets would be calculated after taking hunter harvest outside the park into consideration first.

The Colorado Division of Wildlife Data Analysis Unit management plan would continue to direct elk population management goals outside the park.

The presence of wolves in the park would redistribute elk from traditionally used winter range core areas and would likely cause elk to seek refuge in the town of Estes Park. Assume for the purposes of this analysis that migration between the park and town would continue to occur to some degree.

To minimize potential for transmission of chronic wasting disease, only the carcasses of calves, to the extent possible, would be left in the field following lethal reduction actions.

Fencing would only restrict the movements of elk, moose, and bighorn sheep; a unique fence design would not restrict other wildlife.

To allow a full analysis of Alternative 5, the wolf release alternative, management of the wolf population would be successful and stages subsequent to the initial phase would be implemented. The analysis of effects of Alternative 5 was based on the impacts of a functioning population of not more than 14 wolves in the park.

There is a high degree of uncertainty regarding the ability to manage wolves effectively (i.e., keep wolves in the park) and about the effects of wolves on elk population reduction.

Wolves (either a released or naturally dispersing population arriving from the north) would prey primarily on elk.

The extent of the elk range identified for purposes of this analysis is not expected to substantially change.

Assessment Methods

Each alternative was assessed to determine the effects of the actions relative to elk and their habitat requirements. The consequences of elk population and habitat management to other wildlife species and their habitat conditions are addressed in the "Wildlife" section.

Primary steps for assessing impacts included identifying 1) the location of areas likely to be affected by the proposed alternatives and 2) potential changes in the elk population, habitat, or behavior from current and future elk and vegetation management actions. NPS management of wildlife is not based on single animals but rather focuses on the role of animal populations and species within the ecosystem (NPS 2006b). As such, the objectives of the management plan address restoration and maintenance of the population, and the analysis and thresholds of impact intensity focus predominantly on the effects of management actions at the population level. The National Park Service recognizes that individuals within a population would be affected by management actions. Impacts on individuals are described in the analysis, and those individual effects collectively contribute to population level effects.

Predictions in the change in vegetation over time as a result of changes in elk numbers and densities as a result of a combination of management actions were based on ecosystem modeling and research conducted within the park as well as research and management results in other locations, focusing primarily on elk use in the core winter range. The park-specific scientific literature presented in the USGS open file report (Singer et al. 2002) and summarized in the NPS synthesis of park research on elk and vegetation (Monello et al. 2005) and the references therein were relied heavily upon in the assessment of effect on elk.

To understand the effects of elk and vegetation management methods on the elk population, park resource inventories and management plans, scientific literature, and published technical data were consulted to identify the information contained in this analysis.

The potential incremental effects of each of the action alternatives on elk were compared to the effects of Alternative 1, which would continue current management practices. The following steps were used to perform the analyses:

Identify the issues associated with possible elk population and habitat management approaches.

Establish a series of impact threshold definitions and conditions that would determine if and when a change to the current management practices occurs and the magnitude of that change.

Estimate or determine the change(s) in the elk population that would occur relative to the issues and as a result of implementing the different alternative actions.

Compare the changes identified for each action alternative to what the conditions would be under current management practices and assign appropriate intensity levels based on the impact threshold definitions.

The effects of mitigation measures are accounted for as part of the impact determination (i.e., reduced adverse effects as a result of mitigation are included in the final determination of overall impacts of a particular alternative).

Impact Threshold Definitions

Impact intensity thresholds defined to categorize the effects of the alternatives are presented below. In some cases, the effects of one alternative may be similar to those of another, but with differences small enough so that there is no distinction between intensity levels. To explain the difference, the phrase "similar to, but incrementally greater or less than" is used to state that the intensity level for the two alternatives is under the same category (i.e., negligible, minor, moderate, or major), but differences within that category exist between the two alternatives.

Refer to the "Purpose of and Need for Action" section for a detailed explanation of the "natural range of variation" concept and its derivation.

Intensity of Impact

Negligible: The elk population, its habitat, and the natural processes sustaining both would not be affected, or the effects would be at or below the level of detection. Effects would be well within the range of natural variation and would not be of any measurable or perceptible consequence to the elk population. Human-elk conflicts would be inconsequential. Elk behavior changes would not be detectable. Key ecosystem processes or habitat characteristics supporting the elk population would not be affected.

Minor: Effects on the elk population, its habitat, and the natural processes sustaining both would be detectable. Elk population size, density, structure (i.e., age or sex ratios), and other demographic factors may experience changes, but population characteristics would be relatively stable and within the natural range of variation. Human-elk conflicts would be infrequent and would not affect the population. Elk behavior changes would be detectable, but population-level effects would be small. Key ecosystem processes or habitat characteristics supporting the elk population would not likely change. Population level changes would be unlikely or inconsequential.

Moderate: Effects on the elk population, its habitat, or the natural processes sustaining both would be readily detectable, and would have consequences at the population level. Population size, density, structure, or other demographic factors would likely change, and population characteristics could be outside the natural range of variation. Human-elk conflicts could occur regularly and may affect the population. Elk behavior changes would be noticeable, and population-level effects would occur. Key ecosystem processes or habitat characteristics supporting the elk population may change.

Major: Effects on the elk population, its habitat, or the natural processes sustaining both would be obvious, and would have consequences at the population level. Population size, density, structure, and other demographic factors of the elk population would experience substantial changes that would have consequences at the population level and would be outside the natural range of variation. Human-elk conflicts could be frequent and would affect the population substantially. Elk behavior changes would be obvious, and population-level effects would occur and could affect key characteristics of the population. Key ecosystem processes or habitat characteristics supporting the elk population would change.

Type and Duration of Impact

Beneficial impacts would result in an elk population whose size, density, and other population characteristics (e.g., age and sex ratios, survival, mortality, recruitment) would be within normal parameters. Behavior, habitat**,** necessary resources, general body condition of elk, and natural migration or dispersal characteristics would be consistent with and contribute to meeting the management objectives.

Adverse impacts would cause the elk populations to experience negative effects with respect to size, density, and other population characteristics. The proposed action would restrict or limit behavior, habitat, necessary resources, migration, or dispersal characteristics in a negative manner. An adverse effect would not contribute to meeting the plan's management objectives. An adverse effect could result in the elk population parameters being outside of the natural range of variation.

Duration: Short-term effects would allow recovery in less than three years. Long-term effects would require more than three years for recovery.

Impairment

Impairment of elk population resources or values would occur if a permanent major adverse effect on elk or their habitat affected a large portion of the park. The effect would be highly noticeable, could not be mitigated, and would affect the elk population to the point that enjoyment of the elk resource by future generations would be precluded.

Alternative 1

This alternative would continue the existing park elk population management framework, which consists of allowing elk population size and distribution patterns to fluctuate in response to seasonal, annual, and long-term weather, forage, and other ecological processes in the park. No new management actions would be applied, and the park elk population would continue to be regulated primarily by forage availability and weather conditions. Under this alternative, the elk population would be expected to fluctuate between approximately 2,200 and 3,100 animals (Coughenour 2002), which is considered to be outside the natural range of variation of 1,200 to 2,100 elk. No formal vegetation management program in the park would be developed to address elk-caused effects on forage quantity, vegetative cover, and dominant plant species composition in elk habitat.

The Rocky Mountain National Park / Estes Valley elk population is composed of three subpopulations, one associated with habitats in Estes Park and the other two using habitats in the park. Generally 85% to 90% of the elk population moves seasonally from the relatively low-elevation primary winter range up to alpine habitats and the Kawuneeche Valley in the park. The other elk have become less migratory and stay on the primary winter range throughout the year. The increased browsing pressure of these less migratory elk, combined with the very high elk densities that are found on portions of the primary winter range, contribute to the degraded vegetation conditions that are driving the need for action.

Elk Habitat

Elk habitat is composed of a number of resources and components, including, but not limited to, vegetation (i.e., forage), surface water, topography, slope aspect, areal extent (i.e., space), and the type, density, and structural diversity of cover. Some of these resources are specifically

addressed as separate impact topics elsewhere in this document, but elk habitat is analyzed for each of the alternatives holistically. Another way to understand the need to address elk habitat rather than the individual resources is that habitat is greater than just the sum of its parts (i.e., resources).

Elk habitat in the primary winter and summer ranges would continue to be affected by the large population and high densities of elk. This effect would be pronounced and adverse in those areas where elk densities are characterized as high and very high (greater than 78 elk/mile^2) (Singer et al. 2002) on the core winter range because of degraded forage conditions. Degradation of aspen and riparian willow communities would continue into the future, with the potential decline or loss of resources in these communities that are important parts of elk habitat. The components of aspen and riparian willow communities that contribute to the importance of these habitats include the structural diversity that provides hiding, resting, and thermal cover. The hydrological changes that have reduced surface water up to 69% on the primary winter range (Peinetti et al. 2002) would continue to adversely affect elk habitat in the future. Overall, the continuation of current management policies would result in long-term, local-to-range-wide, moderate-to-major, adverse effects on elk habitat. The range of effects would be moderate for much of the elk habitat, but would be major in localized portions of the primary winter range where habitat conditions would continue to be adversely affected.

Population Size and Density

Under Alternative 1, the size of the Rocky Mountain National Park / Estes Valley elk population would continue to fluctuate above the natural range of variation, at the food-limited carrying capacity of the system. Ecosystem simulation modeling (Coughenour 2002) predicts that the population would fluctuate between 2200 and 3100 elk, assuming no changes in recent weather patterns or habitat availability (e.g., development outside the park). Recent population estimates have indicated that changes in elk distribution, such as temporary or permanent emigration to areas east of the park and Estes Valley, as observed in 2002-2005, could result in years in which the population is less than model predictions. The natural range of variation of 1200 to 2100 elk was estimated based on research and modeling (Coughenour 2002, Singer et al. 2002, reviewed in Monello et al. 2005); refer to the "Purpose and Need" section for a more detailed explanation of the "natural range of variation" concept for the elk population as applied to this analysis.

The continuation of current management actions into the future would not directly change the existing population size. A population that exceeds the upper bound of the natural range would be expected to experience high levels of intraspecific competition. Research indicates that the population is at or approaching the carrying capacity of the elk range (reviewed in Monello et al. 2005). As a result, increased competition, combined with a population that is at or near the limits of its resource base (i.e., carrying capacity) has the potential to adversely affect population health. Population health can be evaluated by looking closer at parameters such as density, body condition of elk, fecundity rates, and other population characteristics. The following paragraphs evaluate some of these parameters in more detail; however, an elk population outside the defined natural range of variation would likely experience a long-term, range-wide, moderate, adverse effect.

Elk densities would continue to be high in the core winter range under Alternative 1. Density-dependent mechanisms that reduce fecundity (i.e., reproductive capability) and body condition (measured as rump fat) in female elk have been found to exist at densities of 52 elk/mile^2 (Stewart et al. 2005). The differing effects of density on male versus female elk is likely related to the wider-ranging movements of bulls, hence lower densities, compared to cows (Forchhammer et al. 1998). Lubow et al. (2002) report low recruitment and low juvenile elk

survival associated with high elk densities. Low recruitment and low juvenile elk survival rates are likely in response to declines in physical condition of adult females (Stewart et al. 2005). The densities found on portions of the park's winter elk range are equivalent to more than 78 elk/mi^2 and have been reported as high as 285 elk/mile^2 (Singer et al. 2002). The areas with these reported densities are limited in size and are reported in terms of mile^2 and should not be interpreted as describing large areas of the park with elk densities at these levels. The association between the high elk densities that are found in specific portions of Moraine Park, Beaver Meadows, and Horseshoe Park and predictable reductions in fecundity, body condition, low recruitment, and juvenile survival would continue to represent a long-term, local, moderate, adverse effect on the elk population.

Elk Behavior, Distribution, and Movement

The elk population is less migratory, more sedentary, and less vigilant than it would be if it were exposed to the predation or hunting pressures experienced by elk populations in other locations (Monello et al. 2005). The absence of a predation threat from the gray wolf and grizzly bear has diminished the vigilance exhibited by elk, particularly for cows with calves (Laundré et al. 2001). Elk can forage for longer periods in locations that no longer pose threats or stress. This behavior represents a long-term, local to range-wide, moderate, adverse effect on the elk population and its habitat because elk foraging is more concentrated, affects specific locations to a much higher degree than if elk were more wary, and contributes to localized habitat degradation. This results in a reduction in overall wildness of the population.

With at least 10% to 15% of the elk population remaining on primary winter range year-round rather than migrating to the primary summer range, forage resources are stressed as a result of the high-intensity grazing and browsing pressure during the growing season (Monello et al. 2005). If the forage resource is degraded, a portion of the elk population using that resource would be adversely affected.

The elk have become habituated to humans as both the elk and human populations have grown and interactions between elk and humans have increased. Habituation to humans and development poses risks to the elk population, although these risks may be partially offset by benefits such as access to higher-nutrient forage (i.e., fertilized grasses) and security from hunters. Human-elk conflicts such as collisions with vehicles, elk cows calving in inappropriate areas (i.e., areas regularly occupied or used by people), or direct land use conflicts in areas such as the golf courses or residential properties in Estes Park represent a continuing adverse effect on the elk population. These adverse effects would be long term, regional, and negligible to moderate, depending on the location and degree of conflict contributing to the adverse population effects.

Population Sex Ratio

The bull:cow ratio could change during the 20-year life of the plan if the Colorado Division of Wildlife changes its management strategy by reducing the number of cow hunting licenses or some other management strategy. However, nothing at this time indicates that such a change would occur. Alternative 1 would have no effect on the continuing trends of sex ratios of the Rocky Mountain National Park / Estes Valley elk population.

Body Condition and Energetics

A continuation of current management of elk in the park would not likely change existing trends or rates of change in elk body conditions or energy expenditures over the 20-year life of the plan. The seasonal increase in energy expenditure and the stressed body condition associated with the rut would continue for bulls (Taber et al. 1982, Lubow et al. 2002). Existing general body condition for some cow elk would likely be less than optimal as a result of the high elk densities in portions of the core winter range. Competition for resources and density-dependent mechanisms would be responsible for the reduced body condition (Stewart et al. 2005). The effects on elk body condition and energy expenditures resulting from continued high elk densities of the core winter elk range would be long term, local, adverse, and moderate.

Park staff conduct an annual helicopter survey on the primary winter range to gather data to assess the size and composition of the elk population. The disturbance and dispersal of elk in reaction to the helicopter and the subsequent increases in energy expenditure would continue to have an annual short-term, winter-range-wide, minor, adverse effect on the elk population.

Chronic Wasting Disease

The continued high densities of elk would contribute to a higher likelihood of transmission of chronic wasting disease in the elk population. The sedentary nature of ungulates on their primary winter range and tendency to congregate in large populations (unlike many other wildlife species, which are behaviorally intolerant of high densities) may increase the probability of contact with sources of infection that reside in the environment (Miller et al. 2004). The increased potential for transmission of chronic wasting disease in the high densities associated with the existing elk population would be a long-term, regional, moderate, adverse effect.

Cumulative Impacts

The bans on low-flying commercial air tours over the park and the use of snowmobiles except on a two-mile-long access trail represent a long-term, range-wide, minor benefit to the elk population because disturbance from motorized noise can adversely affect wildlife as a result of behavioral and physiological effects (USAF and USFWS 1988). Elk in particular are stressed more in response to snowmobiles than by encounters with wheeled vehicles (Creel et al. 2002).

Fuels management and forest health projects in the park and on U.S. Forest Service lands adjacent to the park would affect elk habitat by managing forest fuels using mechanical thinning and prescribed fire and by controlling the pine bark beetle. The effects of these projects would be short-term, minor, and adverse because of temporary disturbance or displacement, but the long-term effect on the elk population would be minor, local, and beneficial as a result of improved habitat conditions.

Construction and trail maintenance and improvement projects would temporarily affect the elk population as small segments of potential habitat would be permanently altered. The effects of these projects on the elk population would be short-term, local, minor, and adverse because of disturbance and displacement and long term, local, negligible, and adverse as a result of the permanent loss of small areas of habitat.

Management plans and actions for protecting the park's natural resources would benefit the elk population by maintaining and restoring natural conditions, managing disease (e.g. chronic wasting disease), and limiting intrusive activities. The effects associated with these management plans would be long term, minor-to-moderate, local, and beneficial. Restoring vegetative

communities and removing exotic plants in the park would also enhance elk habitat, a long-term, minor, beneficial effect on the elk population.

Hunting outside of the park would continue to be managed by the Colorado Division of Wildlife so that habitat conditions are not degraded by the elk population that may grow in the absence of predators. Game management outside the park would help maintain habitat quality for the elk that share habitat inside and outside the park and would represent a long-term, range-wide, minor-to-moderate benefit for the elk population. Illegal hunting or poaching would continue to adversely affect the elk population inside and outside the park, although exact numbers regarding the extent of this problem are not known. This would represent a long-term, range-wide, negligible-to-minor, adverse, impact on the elk population, assuming that illegal hunting may occur at a level that could have some population-level effects.

Continuing development on private lands outside the park would have effects similar to the specific construction projects referred to above, but the specific locations are not predictable. It is likely that some elk habitat that is currently used by the Rocky Mountain National Park / Estes Valley population would continue to be developed and fragmented as a result of the proliferation of homes and development in the region. Although development outside of the park would result in the permanent loss and fragmentation of native habitat, it results in the creation of artificial habitat which is often nutritionally enhanced and provides a refuge from hunting and predation. As a result, the elk population may then continue to grow to levels which are outside of the range of natural variation due to these artificial conditions. The overall effects, therefore, would be long-term, moderate, and adverse.

Overall the population is affected most predominantly by the habitat alterations that are creating adverse effects. Adverse effects of aerial overflights, illegal hunting, small-scale construction projects in the park, development outside of the park contribute somewhat to the overall moderate, adverse effects of habitat alteration. Management plans within the park are providing benefits to the elk population, however, these benefits are outweighed by the moderate, adverse cumulative effects stated above.

Alternative 1 would generally contribute long-term, adverse effects on the elk population ranging up to major. The range of effects would be moderate for much of the elk habitat, but would be major in localized portions of the primary winter range where habitat conditions would continue to be adversely affected. These effects contribute to the overall adverse cumulative effects of other past, present, and future actions, but do not result in an adverse cumulative effect greater than moderate.

Conclusion

Overall, the continuation of current management policies would result in long-term, local-to-range-wide, moderate-to-major, adverse effects on elk habitat.

The size and density of the Rocky Mountain National Park / Estes Valley elk population would fluctuate under Alternative 1 as a result of habitat and forage availability, weather, and hunter harvest outside the park, generally higher than the natural range of variation. This would represent long-term, local and range-wide, moderate, adverse effects. The less migratory, more sedentary, and less vigilant elk population represents a long-term, local to range-wide, moderate, adverse effect on the elk population. Habituation to humans and the potential for human-elk conflict would continue to pose long-term, regional, and negligible-to-moderate effects on the elk population, depending on the location and degree of human-elk conflict that may arise. Alternative 1 would not affect population sex and age ratios, as current trends would continue.

High densities of elk on the primary winter range would continue to have adverse effects on body condition and energy expenditures, resulting in long-term, local, adverse, and moderate effects. Annual aerial monitoring of the elk population from helicopters would contribute to increased energy demands on elk physical conditions as they move away from helicopter flights that approach closely. This effect would be an annual, short-term, winter-range-wide, minor, adverse effect on the elk population.

The increased potential for transmission of chronic wasting disease in the locally high densities associated with the existing elk population would have a long-term, regional, moderate, adverse effect on the population.

The adverse effects of Alternative 1 would contribute to the overall adverse cumulative effects of other past, present, and future actions, but do not result in an adverse cumulative effect greater than moderate.

Using the impairment analysis criteria presented in the beginning of this section, there would be no impairment of elk population values or resources as a result of implementing Alternative 1.

Alternative 2

Alternative 2 would involve agency removal of elk using lethal means, with aggressive reduction targets during the first four years of the plan to quickly reduce the size of the population, followed by less intensive yearly reductions to maintain target populations. The resulting elk population would fluctuate between 1,200 to 1,700 elk, which would be on the lower end of the target elk range of 1,200 to 2,100. Up to 160 acres of aspen (105 acres in winter elk range and 55 acres in summer elk range) would be fenced to protect the stands from elk herbivory and to allow regeneration of aspen if needed based on monitoring. Elk redistribution techniques would be used to better attain vegetation restoration objectives by dispersing high concentrations of elk.

Elk Habitat

The elk population using habitats in the primary winter and summer ranges would be reduced to 1,200 to 1,700 elk. Elk densities in these habitats would be lowered as a result of lethal reduction activities and by targeted redistribution actions that would focus on areas with high densities of elk. Because degraded habitat conditions result from an overabundant or overconcentrated elk population (Monello et al. 2005), these reductions would benefit elk habitat. The benefits would be the result of reduced forage intensities and a more migratory and less sedentary elk population. If based on adaptive management, fences are determined to be necessary, fencing of aspen in the park would restrict elk use of the habitat in the fenced areas. Elk would seek forage elsewhere, and use of aspen stands for cover would be reduced proportionally. Aspen and understory forbs are a minor component of the elk diet, so its restricted availability would offset benefits of this alternative on the elk population to a minor degree.

Overall, regeneration of aspen, restoration of riparian willow communities, and the return of beaver and a subsequent increase in surface water would represent a long-term, local to range-wide, moderate beneficial effect on elk habitat.

Population Size and Density

The actions taken to reduce the size of the elk population would also likely result in lower densities. The high densities and sedentary behavior of elk are primary factors contributing to degraded habitat conditions in the park. Lethal reduction activities could occur at any time of

year and would affect elk from all subpopulations (i.e., Moraine Park / Beaver Meadows, Horseshoe Park, and the town subpopulation). However, most lethal reductions would be performed between November and February to allow the greatest opportunity to reduce the in park subpopulation. Lethal control actions would redistribute elk at differing degrees, depending on whether noise-suppressed weapons would be used or not. Using noise-suppressed weapons at night would help minimize the movement of elk outside the park but could result in localized redistribution. Weapons without noise suppression could be used in areas with high elk concentrations to achieve maximum redistribution effects. A smaller and less dense elk population would benefit from potential increases in fecundity, body condition, and calf survival as density-dependent population-limiting mechanisms would be relaxed (Stewart et al. 2005). The potential increase in reproductive capability accounts for the projected maintenance level of lethal control in elk populations in the last 16 years of the plan. Elk density reductions, achieved through direct population reduction and through redistribution actions, would represent a long-term, range-wide, moderate benefit to the elk population.

There is a degree of uncertainty regarding the ultimate response of elk to redistribution, but in general, benefits to the elk population would be long term, local, and moderate under Alternative 2.

Elk Behavior, Distribution, and Movement

Using redistribution techniques, the elk population that has become less migratory and stays on primary winter range through spring and summer months (Monello et al. 2005) would be forced off the primary winter range to ensure that all elk migrate to the primary summer range. This would represent a return to behavior more typically associated with seasonal elk movements in the Colorado mountains and would relieve foraging pressure on high-use winter range meadows and valley bottoms. An improvement in vegetative conditions would represent a long-term, local, moderate benefit to the elk population as a result of an improvement in the forage resource. The less migratory behavior of the elk population is one of the contributing factors for considering the population outside the natural range of variation (Monello et al. 2005). Encouraging migration, or reversing the trend, would represent a long-term, range-wide, moderate benefit for the elk population.

Redistribution actions and lethal control activities (using both noise-suppressed and unsuppressed weapons) would cause elk to be more wary of people and certain areas of the park. The effects of using noise-suppressed weapons would be less beneficial in terms of making elk more wary, but these techniques would aid in reaching the targeted levels of reduction because they would allow removal of more elk at one location by a reduction team. If a capture facility were needed, the effects on elk behavior for those elk that may be released would be similar to the negative experience associated with being trapped and would increase their wariness. The darting or capturing, anesthetizing, and handling of elk, done in concert with elk management activities, for a three-year research study evaluating procedures for testing live elk for chronic wasting disease and fertility control agent effectiveness in free-ranging elk would result in increased wariness in those subject elk.

In effect, the elk would be reacting to these management actions similarly to how they would react faced with an increased predation risk, namely, with increased vigilance (Laundré et al. 2001). Reducing the level of habituation to people and encouraging increased wariness in elk would represent more "normal" behavior, decreasing the sedentary nature of the elk population. An elk population with increased wariness and lowered habituation to people would reduce the potential for human-elk conflicts, increase population wildness, and contribute to the beneficial effect of the management actions. However, increased wildness achieved by lethal reduction and

redistribution would be offset to a negligible degree for a short period as a result of the research study due to the treatment of elk with fertility agents and markings. Overall, Alternative 2 would have a long-term, range-wide, moderate, beneficial effect on elk population behavior.

Population Sex Ratio

Under this alternative, sex ratios would be managed so that bull:cow ratios would not exceed 80:100. This would represent a 4- to 16-fold increase over the ratios reported in the park between 2002 and 2005. Modelled ratios for the park have predicted a population structure that reaches a high of 60:100, which includes some hunting effects. Therefore 80:100 would not be unreasonable for populations in national parks that are not subject to hunting (Hobbs 2005).

The effects of increasing the proportion of bulls in the population are uncertain. Although portions of the Rocky Mountain National Park / Estes Valley elk population are controlled by the Colorado Division of Wildlife as a hunted population, the increase in the bull:cow ratio could theoretically benefit the elk population by reducing harem sizes. As bull:cow ratios increase, harem size generally decreases (Geist 1982, Bender 1996). Smaller harems would require less energy expenditures by bulls, which in turn would lead to better body condition in bulls and an increased potential to survive harsh winter conditions (Geist 1982). However, the increased ratios may also have adverse effects. For example, smaller harem sizes may not result in less energy expenditure, but be a result of more energy expenditure due to increase bull competition and bulls not being able to successfully defend harems. This could potentially translate into such effects as altered genetic structure of the population, as the largest, most dominant bulls do not breed with as many females as they would under natural conditions. In addition, other factors would also influence the sex structure of the population such as weather, food supply, and hunter harvest outside the park. Annual monitoring of the population would help determine the effects of an increased bull to cow ratio by assessing the survival rate of bull elk in the population.

Body Condition and Energetics

Lethal reduction management actions, including the use of firearms, redistribution activities, overflights, potential use of a capture facility (possibly not all elk captured would be killed if the sex ratio of the captured group did not meet population objectives), and research activities would increase energy expenditures and stress levels in the elk population. Elk responses to human activities could include elevated heart rate and metabolism, elevated stress hormones (i.e., glucocorticoids), reduced reproduction, and diminished health as a result of increased energy costs (Creel et al. 2002; Geist 1978; Picton 1999).

In the long-term, reductions in density would decrease intraspecific competition for resources such as forage and habitat. Decreased competition would reduce the amount of energy expended by elk for resources which would result in an overall long-term, range-wide, moderate net benefit.

Chronic Wasting Disease

Lowering the size and density of elk population could potentially lower the prevalence of chronic wasting disease (CDOW 2004c). Additionally, a less sedentary elk population and dispersal of highly concentrated elk would help lower the risk of disease transmission, as reduced movement and large congregations have been implicated in chronic wasting disease transmission rates because of the increased probability of contact with sources of infection, whether they be direct contact with an infected animal or residual environmental contamination (Miller et al. 2004). However, any use of a capture facility could increase transmission of chronic wasting disease.

The implementation of Alternative 2 would represent a potential long-term, range-wide, minor benefit to the elk population as a result of a reduction in the prevalence of chronic wasting disease.

Cumulative Impacts

The existing cumulative effects of other plans, projects, and actions on the elk population, both in and outside the park, would continue as described for Alternative 1. Overall the population is affected most predominantly by the habitat alterations that are creating adverse effects. Adverse effects of aerial overflights, illegal hunting, small-scale construction projects in the park, and development outside of the park contribute somewhat to the overall moderate, adverse effects of habitat alteration. Management plans within the park are providing benefits to the elk population; however, these benefits are outweighed by the moderate, adverse cumulative effects discussed in Alternative 1 cumulative analysis.

The contribution of Alternative 2 cumulative effects on the elk population as a result of population and density reduction and the subsequent habitat improvements would be long term, range-wide, moderate, and beneficial and short-term, local, moderate, and adverse. The effects of Alternative 2 would offset the adverse cumulative effects from other past, present, and future actions and reduce the long-term, range-wide adverse effect on the elk population to minor.

Conclusion

Relative to Alternative 1 (future baseline condition), Alternative 2 would have the following effects on the elk population.

Maintenance of aspen, restoration of riparian willow communities, and the return of beaver with a subsequent increase in surface water would represent a long-term, local-to-range-wide, moderate, beneficial effect on elk habitat. Fencing of aspen would represent a long-term, local, minor adverse effect.

The reduced elk population size and densities would represent a long-term, range-wide, moderate benefit to the elk population as density-dependent population regulation mechanisms would be relaxed.

Reversal of the trend toward a less migratory population would represent a long-term, range-wide, moderate benefit for the elk population. Redistribution actions, lethal reduction actions, and research activities would reduce the level of habituation to humans, resulting in a moderate beneficial effect, as would the effects associated with lethal reduction actions or the use of a capture facility. However, the beneficial effects of reduction actions using noise-suppressed weapons would be reduced.

Alternative 2 may support a theoretical minor benefit as a result of increased bull survival related to reduced energy expenditures due to smaller harem sizes, but this would be offset by increased competition for cows as well as other environmental factors that would reduce bull survivorship.

The short-term effects of management actions associated with lethal reduction activities, herding, overflights, research activities, and other potentially disturbing actions would increase energy expenditures and stress in elk. Nonetheless, in the long-term, the management actions would reduce competition and energy expenditures for forage that are associated with high densities and represent an overall net moderate benefit to the elk population.

Lastly, Alternative 2 would likely reduce the potential for transmission and prevalence rate for chronic wasting disease in the elk population, resulting in a minor benefit to the population.

Overall, Alternative 2 would have a long-term, local-to-range-wide, moderate, beneficial effect on the elk population.

The overall cumulative effects of other plans, projects, and actions combined with the effects of Alternative 2 would be long-term, minor adverse impacts.

Using the impairment analysis criteria presented in the beginning of this section, there would be no impairment of elk population values or resources as a result of implementing Alternative 2.

Alternative 3

Alternative 3 relies on gradual lethal reduction of elk over time to regulate the elk population and its distribution. Because this alternative would maintain the elk population at the higher end of the natural range (1,600 to 2,100 elk), up to 440 acres would be fenced in riparian willow communities on the primary summer and winter ranges, and elk redistribution techniques would be used to a greater degree to support vegetation maintenance and restoration objectives outside fenced areas. Aspen would be fenced as in all action alternatives (up to 160 acres). Within the analysis of this alternative, where impacts are described as the same as or similar to Alternative 2, those impacts would be realized more slowly than in Alternative 2 because of the gradual rate of population reduction.

Elk Habitat

The effects of Alternative 3 on elk habitat would be similar to those described for Alternative 2, with some important distinctions. Elk densities would be lowered as a result of increased use of redistribution actions, and riparian willow communities in portions of the primary elk range would be fenced. Fencing in willow habitat would be installed at a rate proportional to elk reductions, therefore, current ratios of elk to forage would be maintained and there would be no further reduction in available forage compared to Alternative 1.

Elk habitat in the fenced areas would benefit as a result of relief from foraging pressure, representing a long-term, local, major benefit. Any benefits to willow outside of fences would be realized later in the plan. Overall, elk habitat would be beneficially affected by Alternative 3 in a long-term, local, minor-to-moderate manner.

Population Size and Density

The effects of elk population reductions would occur for reasons similar to those described for Alternative 2. However, because there would be no high-intensity period of reductions in the initial years of the plan and the population would be reduced to the higher end of the target range, the intensity of the moderate benefit experienced by the elk population would be incrementally less than under Alternative 2.

Elk densities would experience declines as a result of the implementation of redistribution activities at a level greater than in Alternative 2. Nonetheless, the effects of actions taken to reduce elk densities would be reduced by a more gradual rate of population reduction over the 20-year life of the plan and by fencing in riparian willow habitat on the core winter range. The implications of the population rate reduction are relatively straightforward: the larger the elk population, the fewer benefits that would accrue.

The effects of fencing willow are more complex. Fencing willow would restrict access for elk (and moose) to preferred foraging habitat. Of necessity, the elk would be forced to forage elsewhere, which could increase density in proximity to the fenced areas, based on the

assumption that elk would only go as far as needed to find adequate forage. Therefore, density reduction due to population reduction and redistribution activities would be slightly offset by locally increased densities outside fences. On balance, the adverse effect of fences around aspen and riparian willow community habitat would be long term, local, and minor because elk would be forced to move to and use alternative habitat.

Installation of fences would be a relatively intrusive operation that would require helicopters to transport fencing and ground crews that would work in elk habitat. The operations would be implemented when most elk were in the primary summer range, and the intrusion of humans would serve to move elk that have not retained seasonal migration behavior. The effects of these operations on the elk population would be short-term, local, negligible to minor, and adverse.

There is a degree of uncertainty regarding the ultimate response of elk to the combined effects of lethal reduction and redistribution, but in general, benefits to the elk population would be long term, local, and moderate, although slightly less than Alternative 2. The reasons for the beneficial determination would be generally the same as described for Alternative 2.

Elk Behavior, Distribution, and Movement

The effects of Alternative 3 on behavior in the elk population would be similar to those described for Alternative 2; long term, range wide, moderate, and beneficial. The similarities would include the effects on migration and habituation to humans and overall population wildness. Although the degree of population reduction would be less under this alternative, behavioral effects would be compensated for by the increase in the use of redistribution activities.

Population Sex Ratio

Alternative 3 would have effects on the elk population sex ratio similar to those described for Alternative 2 as the bull: cow ratio would increase over current conditions. The effects are uncertain: There may be a minor benefit for the elk population if increased bull survival results, but this would likely be offset by increased competition for cows as wells as other factors that affect population structure such as weather, food supply, and hunter harvest outside the park.

Body Condition and Energetics

The short-term adverse effects of redistribution activities, lethal reduction actions, and research activities under Alternative 3 on energy expenditure and the stress levels in individual elk would be similar to those described for Alternative 2 but incrementally greater. No capture facility would be used under Alternative 3, but the primary difference would be based on a greater reliance on redistribution actions under Alternative 3, which would increase stress and energy expenditures.

In the long-term, reductions in density would decrease intraspecific competition. Decreased competition would improve body condition as a result of reduced energy expenditures for habitat and forage and result in an overall long-term, range-wide, minor net benefit that may not be fully realized until riparian willow habitats are fully restored and the fences are removed.

Fencing may affect elk energy expenditures by restricting access to preferred foraging areas or interrupting traditional movement pathways. This could pose additional energetic demands on individual elk to find forage or by taking longer routes to find suitable resting, hiding, or thermal cover. This would represent a negative effect, depending on the areas fenced and the location of

the fenced area in relation to preferred foraging areas or movement corridors. The effects would diminish in the long term as elk adapt to the presence of fences.

Chronic Wasting Disease

The effects of Alternative 3 on the prevalence of chronic wasting disease in the elk population would be similar to those described for Alternative 2. However, because the elk population target would be at the higher end of the target range, the long-term, range-wide, minor benefit associated with Alternative 3 would be incrementally less than with Alternative 2.

Cumulative Impacts

The existing cumulative effects of other plans, projects, and actions on the elk population, both inside and outside the park, would continue as described for Alternative 1. Overall the population is affected most predominantly by the habitat alterations that are creating adverse effects. Adverse effects of aerial overflights, illegal hunting, small-scale construction projects in the park, and development outside of the park contribute somewhat to the overall moderate, adverse effects of habitat alteration. Management plans within the park are providing benefits to the elk population; however, these benefits are outweighed by the moderate, adverse cumulative effects discussed in Alternative 1 cumulative analysis.

Alternative 3's contribution to cumulative impacts would be similar to Alternative 2's, although incrementally less. The overall cumulative effects of Alternative 3 would be similar to the short-term, minor adverse impacts and long-term, range-wide, moderate benefits of Alternative 2, with a small decrease in the benefits to the elk population because Alternative 3 would not realize benefits as quickly as Alternative 2. The effects of Alternative 3 would offset the adverse cumulative effects from other past, present, and future actions and reduce the long-term, range-wide adverse effect on the elk population to minor.

Conclusion

Relative to Alternative 1 (future baseline condition), Alternative 3 would have the following effects on the elk population.

Fencing in riparian willow community would result in similar but fewer benefits to elk habitat than those described for Alternative 2. Overall, elk habitat would be beneficially affected by Alternative 3 in a long-term, local, minor-to-moderate manner as a result of decreased foraging pressure.

The reduced elk population size and densities would have effects similar to, but incrementally less, than the long-term, range-wide, moderate benefit described for Alternative 2.

The effects of fencing in aspen and riparian willow would be two-fold. Installation of the fences would have a short-term, local, negligible-to-minor, adverse effect on the elk population as a result of disturbance. Restricted availability of habitat would have a long-term, minor, adverse effect on the elk population.

Alternative 3's effects on elk behavior and the population's age and sex structure would be similar to those described for Alternative 2: offsetting minor effects as a result of potentially smaller harem sizes but increased male competition and other environmental factors that would reduce bull survivorship.

Body condition and energetics in the elk population would be affected similarly to Alternative 2; however, the negative effects would be incrementally greater because of a greater reliance on redistribution actions and fences, which would increase stress and energy expenditures. The negative effect of fences on elk energy expenditures would diminish as elk adapt to fences. In the long term, management actions would reduce competition and energy expenditures for forage and habitat, representing an overall minor net benefit to the elk population.

The effects with respect to the prevalence of chronic wasting disease would be incrementally less than the long-term, range-wide, minor benefit described for Alternative 2 because the population reductions would not be as great.

The overall beneficial effect of the management actions associated with Alternative 3 on the elk population would be long-term, local, and moderate.

The effects of Alternative 3 would offset the adverse cumulative effects from other past, present, and future actions and reduce the long-term, range-wide adverse effect on the elk population to minor.

Using the impairment analysis criteria presented in the beginning of this section, there would be no impairment of elk population values or resources as a result of implementing Alternative 3.

Alternative 4

Alternative 4 would use fertility control agents (single-year, multi-year, or lifetime duration) on elk inside the park to reduce and maintain the size of the elk population. Currently, due to the high number of elk that would need to be treated annually, it is logistically infeasible to meet the elk population objectives of the plan using only available fertility control agents. Therefore, the alternative involves the use of lethal reduction methods to supplement fertility control actions. Because this alternative would maintain the elk population at the higher end of the natural range (1,600 to 2,100 elk), up to 260 acres of montane riparian willow would be fenced in the primary elk winter ranges and would be installed in a phased manner commensurate with reductions in the elk population, and elk redistribution techniques would be used to a greater degree than Alternative 2 in the early years of the plan to support vegetation restoration objectives outside fenced areas.. Aspen would be fenced as in all action alternatives (up to 160 acres).

Elk Habitat

The effects of Alternative 4 on elk habitat would be the same as those described for Alternative 3. Although the means to achieve elk population reductions would differ between these two alternatives, the ultimate effect would be the same, namely a long-term, local, minor-to-moderate benefit to elk habitat in the primary winter and summer ranges.

Population Size and Density

The effects on elk population size and density would be the same as those described for Alternative 3 with regard to lethal reduction and redistribution. Although the use of a fertility control agent would distinguish Alternative 4 from Alternative 3, redistribution and lethal reduction actions and their effects on population size and density would be similar for each of these alternatives. Alternative 4 would provide a long-term, range-wide, moderate, benefit with respect to the elk population size and density.

Elk Behavior, Distribution, and Movement

Lethal reductions, redistribution, and research activities would affect population behavior, including the degree of habituation to humans and/or migration tendencies, as under Alternative 3: a long-term, range-wide, moderate benefit would accrue through increased wildness in the population. The additional handling and close contact with humans as a result of fertility control activities would increase elk wariness and result in an incrementally greater long-term, range-wide moderate benefit. This benefit would be characterized by a decrease in habituation to humans as a result of the negative experience associated with capture and handling. However, increased wildness achieved by lethal reduction and redistribution would be offset by the treatment of elk with fertility agents and markings, which would reduce the intrinsic wildness in the population. Based on the criteria for the use of fertility control agents, they would have no recognizable affects on courtship, rutting, or breeding behavior of elk. Although the long-term effects of fertility control agents is uncertain, as part of the adaptive management approach, if adverse effects were identified, a new agent would be used or treatment would be stopped. The three-year research study evaluating the effectiveness of a multi-year fertility control agent would contribute to expanding the knowledge of effects of such controls on wild, free-ranging elk.

Population Sex Ratio

Alternative 4 would have effects on the elk population sex ratio similar to those described for Alternative 2 as the bull:cow ratio would increase over current conditions. The effects of this are uncertain: There may be a minor benefit for the elk population if increased bull survival results, but this would likely be offset by increased competition for cows as wells as other factors that affect population structure such as weather, food supply, and hunter harvest outside the park.

Body Condition and Energetics

The negative effects of Alternative 4 on body condition and energetics of individual elk would be similar to those described for Alternative 3 for the lethal reduction, redistribution, research activities, and fencing components. The use of a fertility control agent would have no long-term energetic cost or effect on body condition. However, if Leuprolide is used as the control agent, cows would remain in estrus for approximately two weeks longer than under natural conditions. This would increase energy expenditures by bulls as a result of the expanded breeding period (breeding would occur in elk treated with the fertility control agent although pregnancy would not result) and would represent a negative effect. This would have the potential to affect the ability of bull elk to withstand the rigors of winter if their energy stores were depleted by additional expenditures in a longer rut.

If a capture facility would be needed to treat elk with the fertility control agent, increased stress and energetic expenditures would have a negative effect on individual elk. Responses to human activities would be similar to those described for effects on body condition and energetics in Alternative 2, but potentially greater because of the increased stress associated with not only proximity to humans but from trapping, handling, darting, and administration of the control agent.

Cow elk treated with the fertility control agent would experience a benefit that would offset the negative effects of trapping and handling. The stress and energetic demands of pregnancy, lactation, and giving birth would be eliminated for treated cows, resulting in improved body condition.

In the long-term, reductions in density would decrease intraspecific competition. Decreased competition would improve body condition as a result of reduced energy expenditures for habitat

and forage and result in an overall long-term, range-wide, minor, net benefit that may not be fully realized until riparian willow habitats are fully restored and the fences are removed.

Chronic Wasting Disease

The effects of Alternative 4 on the prevalence of chronic wasting disease in the elk population would be similar to those described for Alternative 3: a long-term, range-wide, minor benefit.

Cumulative Impacts

Cumulative effects of other plans, projects, and actions and the contribution of Alternative 4 to those effects would be the same as described for Alternative 3.

Conclusion

Relative to Alternative 1 (future baseline condition), Alternative 4 would have the following effects on the elk population.

The effects of Alternative 4 on elk habitat would be the same as those described for Alternative 3: long-term, local, minor-to-moderate benefit.

Although Alternative 4 would use a fertility control agent to implement population regulation in the elk population (in addition to lethal reduction and redistribution activities), the long-term, range-wide, moderate, beneficial effects on population size and density would be the same as described for Alternative 3.

Lethal reductions, redistribution, research activities, and remote administration of the fertility control agent (i.e., darting) would affect population behavior, including the degree of habituation to humans, and migration tendencies, the same as Alternative 3: a long-term, range-wide, moderate benefit would accrue. However, behavior effects as a result of capturing elk to administer the control agent would be incrementally greater because the wariness of elk would increase and a reduction in habituation to humans would occur as a result to being trapped and handled.

Sex ratios of the elk population would be affected in the same manner as described for Alternative 2: a long-term, range-wide, minor benefit could accrue; however, it would likely be offset due to increased male competition and other environmental factors that would reduce bull survivorship.

The negative effects of Alternative 4 on body condition and energetics of individual elk would be similar to those described for Alternative 3 for the lethal reduction, redistribution, research activities, and fencing components. As a result of fertility control, energy expenditures by bull elk could be greater because of a two-week longer rut if Leuprolide were used as the control agent. Likewise, excess stress and energy expenditure associated with capture would represent a short-term, negative effect on individual elk. Negative effects of handling and treatment would be offset in cow elk as the stress of pregnancy, lactation, and birth would be eliminated. Negative effects would also occur to individual elk as a result of increased redistribution actions and use of fences. In the long-term, management actions would reduce competition and energy expenditures for forage and habitat, representing an overall minor net benefit to the elk population.

The effects of Alternative 4 on the prevalence of chronic wasting disease in the elk population would be similar to those described for Alternative 3: a long-term, range-wide, minor benefit.

Overall, balancing the various positive and negative effects of the management actions, the effects of Alternative 4 would be long term, local to range-wide, minor-to-moderate, and beneficial.

The effects of Alternative 4 would offset the adverse cumulative effects from other past, present, and future actions and reduce the long-term, range-wide adverse effect on the elk population to minor.

Using the impairment analysis criteria presented in the beginning of this section, there would be no impairment of elk population values or resources as a result of implementing Alternative 4.

Alternative 5

This alternative would involve releasing a small population of gray wolves in Rocky Mountain National Park in a phased approach, in combination with lethal control of elk, to achieve an elk population that would fluctuate within the natural range of variation between 1,200 to 2,100 elk. Wolves would be established in the park in very small numbers in the early phase of the plan and gradually allowed to increase in later phases if it is determined that the wolves can be effectively managed and that plan management objectives are being met. Wolves would be monitored and their movements and activities restricted to the park. As wolf predation of elk in the park increases, and based on monitoring of the elk population, the intensity of lethal reductions by NPS staff and their authorized agents would be modified to meet elk population objectives. Wolves would effectively redistribute the population; therefore, no other elk redistribution techniques or fencing of riparian willow habitat would be required to support vegetation protection and restoration. Aspen would be fenced as in all action alternatives if needed based on monitoring of vegetation response (up to 160 acres).

Elk Habitat

The presence of wolves on the winter elk range would result in an increased distribution of elk as they avoid predation. Elk and wolves may alter their behavior over time with wolves changing their activity patterns over the landscape in response to the redistribution of elk. Elk would continue to forage on aspen and willow on the elk range, resulting in a patchy distribution types reflective of more natural conditions. Therefore, it is quite possible that increases in willow could fluctuate over time (Fortin et al. 2005). The effect of wolves in redistributing elk would result in recovery of vegetation through an increase in cover and structural diversity that would benefit a wide range of other wildlife species. Ripple et al. (2001) and Hebblewhite et al. (2005) have documented this type of response in Yellowstone and Banff National Parks, respectively. The benefits to elk habitat as a result of Alternative 5 would be long term, local to range-wide within the park, and moderate to major.

Population Size and Density

During the first phase of Alternative 5, lethal reduction actions would be the primary management tool that would affect the size of the elk population. Lethal reductions would have effects similar to those described for Alternative 2, although the effects would be incrementally less than the long-term, range-wide, moderate benefit under Alternative 2 because the target population would be 1,600 to 2,100 during the first four years and 1,200 to 2,100 during the last 16 years of the plan rather than 1,200 to 1,700.

The presence of wolves on the primary winter range would have a substantial effect on elk density. In Yellowstone National Park following the reestablishment of wolves (Laundré et al.

2001, Fortin et al. 2005) and in Banff National Park, Canada (Hebblewhite et al. 2005), elk use of habitat underwent a large shift as a result of the presence of a primary predator. Elk use of riparian and wet meadow communities decreased in Yellowstone in areas frequented by wolves (Ripple et al. 2001). Some of the highest reported densities of elk are found in the montane riparian and wet meadow community habitats in and around Moraine Park, Beaver Meadows, and Horseshoe Park in Rocky Mountain National Park (Monello et al. 2005). The presence of wolves in Rocky Mountain National Park would likely reduce the density of elk in these areas of the primary winter range, possibly to a greater extent than by the human means used in the other alternatives. However, the reluctance of wolves to use developed areas in and around the core winter range may reduce their effect on elk density. Reduced densities would offset the existing adverse effects described under Alternative 1, and compared to Alternative 1, represent a long-term, local, moderate benefit on the elk population.

Elk Behavior, Distribution, and Movement

The presence of wolves, combined with the effects of lethal reduction activities, would make elk in the park more wary. Increased wariness in the park would reduce habituation to humans and the sedentary behavior that contributes to degradation of habitat. However, the presence of wolves in the park may cause elk to use Estes Park as a refuge from predation because wolves would not be permitted to leave the park. The number of elk that might move from the park to town would not exceed current population movements because lethal reduction actions in the park would reduce the size of the population proportionally between the park and town subpopulations. Nonetheless, if elk move to the habitats in and around Estes Park, habituation to humans and development could increase for the segment of the population that moves out of the park. However, it should be noted that elk in areas surrounding Banff National Park in Canada are less habituated to humans because their natural instincts have been heightened by the presence of wolves in the area (Ronca 2006). The increased wariness, increase wildness, and reduced habituation in the park could be offset by the reverse effect outside of the park. Overall, the benefit in terms of elk behavior would be long term, local, and minor-to-moderate in the park and minor outside the park.

Wolves in the park would likely use montane areas and den in lower elevation portions of the primary winter range. The presence of wolves on the primary winter range in summer could encourage elk migration to traditional summer elk range at higher elevations. This effect would be similar to the human management actions taken under Alternative 2 to encourage migration, but would be incrementally greater than Alternative 2's long-term, range-wide, moderate benefits because of the natural component that would drive the migratory elk behavior and the continuous presence of wolves versus scheduled, discrete human management actions.

Over time, elk would exhibit behavior to avoid predation as they adapt to the presence of the wolves. Elk with superior predator avoidance behaviors would survive and be more likely to reproduce. This would represent a long-term, range-wide, minor-to-moderate benefit as overall fitness (i.e., probability of producing offspring) of the elk population would increase as behavior that avoids predators is learned (Lind and Cresswell 2005).

Population Sex Ratio

Alternative 5 would have effects on the elk population sex ratio similar to those described for Alternative 2 in the initial stages of implementation because population regulation would be primarily accomplished using lethal reduction actions. The reduction targets would be adaptively managed to achieve the sex ratios associated with Alternative 2. The bull:cow ratio would

increase over current conditions with potential minor benefits as described for Alternative 2; however, there would be predation on bulls by wolves to some degree, reducing bull survivorship in combination with environmental factors that affect the population structure offsetting the beneficial effects.

Body Condition and Energetics

Short-term effects on energy expenditures and stress levels in individual elk associated with lethal reduction activities and capture and handling of elk for a research study would be similar to those described for Alternative 2. Elk would experience an increase in their energy expenditure and stress levels as a result of the increased risk of predation by wolves.

In the long term, the effects of the population reduction and lower densities of elk would decrease intraspecific competition. Decreased competition would reduce the amount of energy expended for forage and habitat by elk. In addition, wolves would be expected to prey on the less fit individuals in the population, thereby improving the overall fitness of the population. The overall net benefit to the elk population under this alternative would be long-term, range-wide, and moderate.

Chronic Wasting Disease

Wolves would be more likely to prey on weaker, diseased elk than stronger, healthy elk (Mech et al. 1995), suggesting that wolves would preferentially prey on elk infected with chronic wasting disease in Rocky Mountain National Park. If such selective predation on elk with chronic wasting disease occurs, it would remove a higher proportion of diseased animals from the population than would be expected based on the current incidence of chronic wasting disease. This could lower the chronic wasting disease prevalence rate and would be a long-term, range-wide, minor-to-moderate benefit for the elk population.

Cumulative Impacts

The existing cumulative effects of other plans, projects, and actions on the elk population, both inside and outside the park, would continue as described for Alternative 1. Overall the population is affected most predominantly by the habitat alterations that are creating adverse effects. Adverse effects of aerial overflights, illegal hunting, small-scale construction projects in the park, and development outside of the park contribute somewhat to the overall moderate, adverse effects of habitat alteration. Management plans within the park are providing benefits to the elk population; however, these benefits are outweighed by the moderate, adverse cumulative effects discussed in Alternative 1 cumulative analysis.

An additional cumulative benefit would be related to the Colorado Division of Wildlife's preparation of a statewide wolf management plan, based on the Colorado Wolf Management Working Group's December 2004 recommendations. This plan would incrementally add to the cumulative beneficial effects of other plans and projects because there would be a management plan developed to address the natural return of wolves to the state. Although modeling indicates that the Rocky Mountain National Park is less than optimal for long-term establishment of a free-ranging wolf population (Carroll et al. 2003), there is a possibility that wolves could naturally return to Colorado (CDOW 2003b, CWMWG 2004). Based on that possibility occurring within the 20-year life of this plan, a management plan to deal with wolf issues would benefit the elk population as a result of wolf-related habitat and ecosystem improvements and the resulting increased fitness of the elk population. These benefits would occur for the same reasons as those

described in the analysis of a released wolf population in the park, although a naturally occurring wolf population would not be restricted within the park boundaries.

Alternative 5's contribution to the overall cumulative impacts on the elk population would be similar to Alternative 2's, although the release of wolves would have additional short-term and long-term adverse effects for elk, as well as long-term, range-wide benefits that would be incrementally greater than the benefits associated with Alternative 2. The effects of Alternative 5 would offset the adverse cumulative effects from other past, present, and future actions and reduce the long-term, range-wide adverse effect on the elk population to minor.

Conclusion

Relative to Alternative 1 (future baseline condition), Alternative 5 would have the following effects on the elk population.

In general, the effects of Alternative 5 are similar to those described for Alternative 2, with some important differences. The benefits to elk habitat as a result of Alternative 5 would be long term, local to range-wide within the park, and moderate to major as a result of redistribution of elk by wolves and the range-wide effects that would improve habitat conditions throughout the elk range. The effects on elk population size and density would be similar to the long-term, range-wide, moderate benefits described for Alternative 2, but incrementally less because of the wider target range for the elk population. If their numbers and use of the elk primary winter range for predation are high enough, wolves would affect elk density, such that the effect would be long term, local, moderate, and beneficial as a result of dispersing concentrations of elk in montane riparian willow communities.

Lethal reduction and research activities, combined with the threat of predation, would decrease habituation to humans, increase the wariness and wildness of elk, and decrease elk sedentary behavior; all these behavioral effects would be long term, local, minor-to-moderate, and beneficial. This benefit would be minor-to-moderate rather than moderate because if elk respond to wolves by taking refuge in Estes Park, the benefit would be somewhat reduced because habituation to humans would increase.

Wolves would likely increase elk movements, including encouraging traditional migratory behavior. This would represent a long-term, range-wide, moderate benefit.

The overall fitness of the elk population would increase in the long term because natural selection processes would select those elk with superior predator avoidance skills. This would be a long-term, range-wide, minor-to-moderate benefit for the elk population.

Effects on the sex ratio of the elk population would be similar to those described for Alternative 2. With an increase in the bull to cow ratio, there may be minor benefits to bull survival as a result of smaller harem sizes, but these would be offset by increased bull competition, predation by wolves, and other environmental factors that reduce elk survivorship.

Short-term effects on body condition and energetics in individual elk associated with lethal reduction activities and research activities would be similar to those described for Alternative 2. The threat of wolf predation would also increase stress and energy expenditures in elk. However, in the long term, the elk population would be smaller and less dense, reducing energy expenditures for forage and habitat. Wolves would also increase the fitness of the population by removing the less fit. Overall, this would represent a range-wide, moderate net benefit to the elk population.

Wolves would preferentially prey on young, old, weak, and diseased elk. This has the potential to reduce the prevalence of chronic wasting disease in the elk population, resulting in a long-term, range-wide, minor-to-moderate benefit.

The effects of Alternative 5 would offset the adverse cumulative effects from other past, present, and future actions and reduce the long-term, range-wide adverse effect on the elk population to minor.

Using the impairment analysis criteria presented in the beginning of this section, there would be no impairment of elk population values or resources as a result of implementing Alternative 5.

VEGETATION

Summary of Regulations and Policies

Management Policies states that the "fundamental purpose" of the national park system begins with a mandate to conserve park resources and values and provide for the public enjoyment of the park's resources and values to the extent that the resources will be left unimpaired for future generations. Section 1.4.6 identifies native vegetation as a park resource, and Section 4.4.2 provides general principles for the maintenance of natural resources in the park by preserving and restoring the natural abundances, diversities, dynamics, distributions, habitats, and behaviors of native species (NPS 2006b).

Riparian shrub and herbaceous vegetation are large components of the wetland habitat found within the park and are focal vegetative groups discussed in this analysis. The National Park Service must comply with Executive Order 11990, Protection of Wetlands, which requires federal agencies to avoid the short- and long-term, adverse impacts associated with the destruction or modifications of wetlands whenever possible and to preserve and enhance the natural and beneficial values of wetlands. NPS management policies and Director's Order 77-1: Wetland Protection requires parks to protect wetland habitat from degradation and to restore natural wetland functions and values where human activities have disturbed them.

Methodologies and Assumptions for Analyzing Impacts

Geographic Area Evaluated for Impacts

Issues and concerns regarding vegetation degradation within the park focus on the primary winter and summer ranges that the Rocky Mountain National Park / Estes Valley elk population inhabit. Therefore, the area of analysis of effects of elk and vegetation management actions focuses on vegetative communities within the elk range. The vegetative types within these ranges that are analyzed include non-conifer-associated aspen (referred to as aspen unless stated otherwise), riparian shrub (referred to as willow and including willow in the montane, subalpine, and alpine areas of the elk range), bitterbrush and sagebrush, riparian and upland herbaceous, and subalpine and alpine herbaceous. This vegetation that occurs on the elk range is most impacted by elk herbivory, has been well studied, and is expected to be most affected by the proposed management alternatives.

Issues

Issues regarding the effects of elk and vegetation management activities on vegetation were identified through internal and public scoping. These issues include the following:

Areas of important aspen and willow are being lost and degraded because of direct and indirect effects of the park's elk population size and density.

Long-term vegetation regeneration and reproductive processes are being substantially degraded in some locations to the degree that this vegetation could be lost from the park's landscape.

High elk numbers and densities affect the reproduction and distribution of vegetative species, which results in changes in plant community structure and composition.

Vegetation diversity and associated habitat functions are being degraded and could be lost in areas of the park if current elk population size and densities and vegetation condition trends continue.

The changes in vegetation condition on the elk range are exacerbated by reduced water levels and the dramatic decrease in the beaver population in the park. Beaver activity helped maintain higher water levels in many of the streams and adjacent areas in the analysis area, encouraging and nurturing montane riparian willow growth. Elk grazing and a change in water table cause a shift from tall to short willow and culminate in a successional shift on the primary winter range from montane riparian willow to grassland areas or from early stage successional communities to later successional types.

High elk densities in some locations during certain times of the year may also lead to an increase in bare ground, which may increase exotic plants in the area.

Due to the degraded condition of the vegetation and the high level of elk herbivory on the range, the use of prescribed fire to stimulate regrowth in aspen and montane riparian willow habitats has been inhibited.

Adverse impacts on vegetation may occur as a result of elk-capture facilities, use of equipment and personnel to access areas of the park, removal of elk carcasses, and installation of exclosure/enclosure fences.

Adverse indirect effects may occur as a result of potential increases in mule deer and moose as a result of lowered abundance of elk.

Assumptions

All assumptions relevant to vegetation are presented in the "General Methodology" section.

Assessment Methods

Vegetation in the park was digitally mapped and the acreages of aspen, montane riparian willow, upland shrub, riparian and upland herbaceous communities, and subalpine and alpine vegetation that occur within the elk range were determined. The geographic information system (GIS) coverage of the vegetation and the elk range were overlayed, and each vegetation community was quantified by acreage. This provided information on the maximum amount of vegetation by type that was known to be affected by elk herbivory but not on how extensively the communities were used by elk.

Predictions in the change in vegetation over time as a result of changes in elk numbers and densities and a combination of management actions were based on ecosystem modeling and research conducted within the park as well as research and management results in other locations, focusing primarily on elk use in the core winter range. The park-specific scientific literature presented in the USGS open file report (Singer et al. 2002) and summarized in the NPS synthesis of park research on elk and vegetation (Monello et al. 2005) and the references therein were relied heavily upon in the assessment of effect of elk herbivory on vegetation. Ecosystem modeling by Coughenour 2002 and Weisberg and Coughenour 2003 evaluated response of aspen and montane riparian willow on the primary winter range to various management scenarios. The results presented in the action alternatives for montane riparian willow based on ecosystem modeling (Coughenour 2002) assumed that there were increased water table heights, and therefore the analysis impacts are a result of the actions in the alternatives as well as increased water availability.

Information on the specific effects of elk herbivory on vegetation in areas of the elk range outside the core winter range is limited. Where research has been conducted in these areas, it was relied on to assess effects. When area specific research was not available, effects of elk herbivory in these other areas of the elk range were extrapolated from core winter range studies. However, the intensity of effect was considered to be less because the current condition of the Kawuneeche Valley is changing less quickly than that of the core winter range due to the primary summer range being larger, elk densities being lower, and forage availability being higher.

Analysis of effects of elk herbivory on vegetation also relied on park research that involved the use of exclosures to show the condition of and response of vegetation when herbivory by elk and/or deer was excluded. Effects were assessed recognizing that some level of herbivory by both deer and elk is natural and would continue under all of the alternatives. This research, however, provided evidence of the potential vegetative response to herbivory from which to evaluate effects of management actions. The evidence of elk herbivory effects based on four-year and 35-year exclosure studies that excluded both elk and deer from foraging was included in the analysis of effects to illustrate the short- and long-term types of changes that would occur in vegetative communities when vegetation is not exposed to grazing. However, the degree of vegetative response was adjusted in the analysis qualitatively, considering that some natural level of herbivory to vegetation would occur to some degree under the alternatives and that the management actions being evaluated for this plan would only occur for 20 years.

In addition, relevant information obtained in the literature was used when park-specific studies were not available.

The analysis of the changes in vegetative condition under Alternative 1 was based on the continuation of the existing condition of the vegetation on the elk range and additional changes that would occur in this condition over time.

The following parameters were used to evaluate vegetation effects:

Community structure.

Species composition.

Age and class structure.

Stand vigor of vegetation.

Distribution of vegetation.

Abundance and rarity of a vegetation type within the park or region. If a community or species is rare, then impacts on that vegetation were considered to be greater.

Sensitivity of vegetation to disturbance due to environmental factors such as elevation, temperature, and soil condition, which inhibit recovery.

Ability of and time for a vegetation type to recover from herbivory and other effects. Potential for exotic plant infestation.

Impact Threshold Definitions

Intensity of Impact

Negligible: Individual plants may occasionally be affected, but measurable or perceptible changes in the vegetation size, integrity, or continuity would not occur.

Minor: Effects on plants would be measurable or perceptible. The natural function and character of the vegetation would not be affected.

Moderate: A change would occur in the natural function and character of the vegetation in terms of growth, abundance, reproduction, distribution, structure, or diversity but not to the extent that the basic community properties change.

Major: Effects on community parameters would be readily apparent and would substantially change the natural function and character of the plant.

Type and Duration of Impact

Beneficial: Abundance, distribution, structure, and species richness of vegetation would increase, and potential for exotic plants species infestation would decrease.

Adverse: Abundance, distribution, structure, and species richness of vegetation would decrease, and potential for exotic plants species infestation would increase.

Duration: For short-term impacts, changes in vegetation would be apparent over two or three growing seasons or less. For long-term impacts, changes in vegetation would be detectable over multiple seasons and could persist over the next 20 years and beyond.

Impairment

Impairment to the vegetation would occur when the action(s) contributes substantially to deterioration of the vegetation in the park to the extent that the vegetation would no longer function as natural communities.

Alternative 1

Aspen

Aspen in certain portions of the elk range are disappearing from formerly occupied locations. Existing aspen stands are slowly shrinking in size and decreasing in overall stand health and vigor. The primary reason for these changes is suppressed aspen reproduction because elk browsing is removing the young age classes before they can mature into young trees that are resistant to elk browsing. Suppression of aspen stands and gradual decline or loss of historic aspen locations is undesirable because of aspen's role in supporting many other bird and plant species beside elk. Evidence of these effects are shown by the plant differences visible inside and outside the numerous research exclosures that are maintained throughout the park. Alternative 1 would continue this condition and gradual decline or loss of aspen. When aspen clones are lost in localized areas, they may serve as an indication that the system is outside of its range of natural variability. This decline or loss would be considered a long-term, major, adverse impact.

Aspen represent 2% of the total vegetation on the elk range. The effects of elk on aspen would continue to be a predominantly localized problem specific to areas within the core winter range (e.g., Moraine Park, Beaver Meadows, and Horseshoe Park) and the primary summer range in the Kawuneeche Valley (Suzuki et al. 1999). In these areas, elk herbivory would be expected to continue to prevent aspen from regenerating, as aspen suckers less than eight feet tall are currently unable to escape elk herbivory (Olmstead 1979 and 1997, Baker et al. 1997, Suzuki et al. 1999).

Elk herbivory on the primary winter range would continue to be high, thereby suppressing aspen regeneration in specific areas of the primary winter range. Aspen cohorts in core winter range do not regenerate at elk numbers higher than 600 (Olmstead 1979), and under this alternative with no management of the elk population, elk numbers on the primary winter range in particular would fluctuate around could range up to 1,000 animals. As a result, only 20% of the aspen within the winter range would be expected to regenerate (Suzuki et al. 1999; Kaye et al. 2003), and the annual percent offtake by elk in aspen would continue to be approximately 18% or higher. The inability of aspen to regenerate on the primary winter range would continue over time. As a result, the number of areas on the primary winter range that are composed of entirely dead standing and downed trees with no live trees would continue to increase.

Modeling has indicated that an elk population size fluctuating between 800 and 1,100 in the park on the primary winter range over the next 20 years would result in a further reduction in the percent cover of aspen by approximately 7 to 10% (Coughenour 2002). It is predicted that over 50 years, the tree aspen in some stands of the core winter range would likely die out or persist as shrub aspen as has been observed in Yellowstone (Renkin and Despain 1996).

Elk densities would also presumably continue to affect aspen regeneration. Currently, densities in some areas of the core winter range exceed 261 elk/mile^2. Modeling has shown that densities would need to be below 26 elk /mile^2 on the elk winter range to allow aspen regeneration (Weisberg and Coughenour 2003), and the probability of regeneration is higher if younger aspen cohorts are present. Without management action to reduce and redistribute the elk population under this alternative, aspen ability to regenerate, particularly older stands in localized areas on the core winter range, would continue to be severely reduced.

High levels of elk herbivory and densities have also led to a decline in aspen stand structure that would continue under this alternative. As herbivory continues at approximately the same level of intensity over time, stands would continue to age with no regeneration. Olmsted showed that stands on the primary winter range that receive greater than 50% use by elk display a uniform age distribution (1979). On the core winter range, the number of large trees has declined by 42% over a 20-year study period (Olmsted 1997), and in high elk-use areas, the ratio of live to dead trees is half that of ungrazed sites (Baker et al. 1997). In highly grazed areas, aspen stands have also been shown to have more dead and fewer live branches (Baker et al. 1997). With the continued high level of grazing by elk, aspen would be unable to regenerate in high elk use areas of the primary winter range and over time, the older trees would continue to die, leading to further reductions in overall stand sizes on the primary winter range.

In contrast to the core winter range, the primary summer range is much larger, elk densities are lower, and forage availability is higher. There is limited documented evidence of the effects that elk have had on aspen in the primary summer range. A few studies have indicated a lack of regeneration of aspen in the Kawuneeche Valley, which has been attributed to locally heavy elk use in both the winter and summer (Suzuki et al. 1999, Kaye et al. 2003). On the primary summer range at elevations above 9,000 feet, there is evidence that nearly 70% of the aspen stands can regenerate (Suzuki et al. 1999). These conditions would continue under this alternative.

Because of the rarity of aspen within the range, the continued high level grazing by elk, particularly in localized areas on the core winter range and on the primary summer range, would be a long-term, major, adverse impact on aspen.

Under Alternative 1, prescribed fire would not be used as a tool to stimulate growth of vegetation. At current levels of elk numbers and densities, a combination of fire and elk grazing would negatively impact aspen (Nesvacil and Olmsted 2002). Fire is not necessary for the persistence of

aspen stands on the elk range that are of management concern, as these stands are successional to grassland, although fire would stimulate some sucker production. An inability to use prescribed fire in these stands under this alternative would have a major, long-term, adverse effect.

Montane Riparian Willow

Under this alternative, approximately 1,190 acres of montane riparian willow on the primary winter range and in the Kawuneeche Valley would continue to be affected by high levels of elk herbivory in combination with drier conditions (see "Hydrology" section in Chapter 3 for more detail). Continued high levels of elk herbivory and reduced surface water that would continue to occur under this alternative would affect montane riparian willow reproduction and seedling establishment, distribution, productivity, and morphology.

Elk herbivory in the primary winter range would continue to lower willow seed production, dispersal, and survival. High elk population levels would continue to severely inhibit seedling establishment on the elk range by a lack of seed rain and seedling survival, primarily due to the effects of herbivory. Few willows in the core winter range would produce seed because the condition of willow stems would be poor due to heavy elk browsing. Elk herbivory and the lack of beaver and their associated habitats would continue to decrease available suitable seed establishment sites, willow reproduction, and growth (Zeigenfuss et al. 2002, Cooper and Gage 2003, B. Baker et al. 2005). Willow declines on the primary winter range have been correlated to a large reduction in surface water and a severe reduction (greater than 90%) in the beaver population in the area (Peinetti et al. 2002, Zeigenfuss et al. 2002).

Montane riparian willow growth and survival primarily depend on ground water from streams and snowmelt (Alstad et al. 1999); large expanses of montane riparian willow have died where streams have become totally dry and water tables have dramatically decreased. The decrease in water table on the primary winter range in particular has been attributed to the dramatic reduction in beaver (see "Water Resources" section of this chapter). Plants further removed from streams have a decreased ability for roots to reach groundwater sources due to high levels of elk browsing (Menezes et al. 2002). Elk browsing results in plants expending more energy in the development of aboveground stems and leaves and less allocation of energy in the production of roots (Menezes et al. 2002; Peinetti et al. 2001), decreasing the ability of the plants to reach deeper water sources. The relative effects of elk and water are further evidenced by findings that many streamside plants with excellent water availability are also in poor condition because of elk browsing (Peinetti et al. 2001, Zeigenfuss et al. 2002, Cooper et al. 2003).

Under Alternative 1, continuing current elk numbers and densities and absence of beaver would result in an inability of willow to establish on the core winter range, seed production would continue to be limited, and seedlings would continue to be over browsed. This would limit further the ability of montane riparian willow in these areas to reproduce, and therefore a continued decline in the amount of montane riparian willow would occur over the next 20 years.

One of the primary factors reducing the productivity in montane riparian willow on the primary winter range is elk herbivory (Schoenecker et al. 2004). Exclosure experiments suggest that elk are affecting willow production, as plots that did not experience elk grazing increased plant production up to 66% after four years and 98% after 35 years (Schoenecker et al. 2004 Zeigenfuss et al. 2002). Peinetti et al. (2001) found an increase in aboveground productivity as a compensation for tissue removal by elk. However, continuous browsing by elk at the high levels that occur under this alternative would result in willow compensating for this grazing pressure by reducing the belowground growth of roots, particularly under drier conditions that exist on the primary winter range.

Elk also affect the growth and size of the montane riparian willow community. Elk browsing levels on the primary winter range dramatically reduce willow height (Peinetti et al. 2001, Schoenecker et al. 2001, Zeigenfuss, Singer, Williams, et al. 2002) and volume (Peinetti et al. 2001, Schoenecker et al. 2001). Plants that are browsed are shorter and the canopies are smaller compared to unbrowsed plants. Willows that are protected from browsing have been shown to be 66% taller in a four-year period than those that are browsed (Schoenecker et al. 2004). Browsing over a longer period (35 years) reduced willow volume, height, and stem density, as indicated by willow not subject to browsing on the core winter range that increased in these measures by 98% compared to unbrowsed areas (Schoenecker et al. 2004). As a result, areas of the core winter range have experienced a transition of tall willow to short willow over the last 60 years; this transition would continue to occur under Alternative 1.

Elk herbivory and density are strongly correlated to willow growth, morphology, and size (Singer et al. 2002). Willow growth and size are negatively affected at elk consumption rate of 37%. The average annual willow consumption on the primary winter range has been at approximately 33% and would be expected to continue at this rate under Alternative 1. Elk densities greater than 83 elk/mile^2 have resulted in a 40% decline in willow size and growth parameters. Elk densities range from 26 to 286 elk/mile^2 in the grassland and montane riparian willow communities of the core winter range. Throughout the rest of the primary winter range, elk densities are less than 26 elk/mile^2. These areas primarily consist of forested areas that are not considered prime feeding habitats for elk (Singer et al. 2002).

As the number of plants declines and the morphology of the plants changes, the overall canopy cover would be reduced (Schoenecker et al. 2004). Modeling predicts that without any changes in management actions, which would allow continuation of the elk population wintering in the park between 800 and 1,100, and at current water table levels, willow cover within suitable montane riparian willow habitat would decline slightly from the 22% that exists on the primary winter range (Coughenour 2002).

Under this alternative, grazing at high levels by elk would produce morphological changes in the willow that would continue to constrain plant growth and development and would inhibit willow reproduction and establishment, particularly in areas on the primary winter range. High browsing levels by elk would continue to reduce the abundance, competitive ability, and survival of montane riparian willow, particularly under the drier conditions that would continue to occur on the primary winter range. Montane riparian willow would continue to transition from taller willow areas to shorter areas and be converted from shrub habitat to grasslands. In localized area of the core winter range where elk densities would continue to be excessive (up to 260 elk/mile^2), the long-term, adverse impacts on montane riparian willow would be major; in other areas of the range where densities are lower, the long-term, adverse effects would be minor to moderate.

Montane riparian willow are also present on the primary summer range (570 acres), and although limited data exist for elk herbivory effects on willow there, anecdotal observations by park staff and researchers have led to growing concern that elk are adversely affecting willow in this area much as described above for the primary winter range. Montane riparian willow establishment in the Kawuneeche Valley has also been depressed as a result of lower groundwater and consequent reduction in the moist soils (Cooper et al. 2000). This reduction in potential for establishment in combination with continued elk herbivory would result in impacts on willow reproduction, seedling establishment, height, volume, and cover similar to those on the primary winter range discussed above. The long-term, adverse effects that elk have on montane riparian willow on the primary summer range would range up to major over a 20-year period.

Under Alternative 1, the use of prescribed fire in the elk range would continue to be prohibited. Due to the degraded condition of montane riparian willow on the elk range, particularly in the

core winter range, fire would not be used as a regenerative tool or to reduce fuel loads in the area because grazing pressure post-fire would further damage the montane riparian willow (Nesvacil and Olmsted 2003). Fire has not been shown to be necessary for montane riparian willow regeneration; however, it can speed regenerative processes (Baker et al. 2005). The continued inability to use prescribed fire under this alternative would have a long-term, major, adverse effect on montane riparian willow on the elk range.

Upland and Riparian Herbaceous Plants

Because a quarter of the elk remain on the primary winter range year round, they inhibit the regrowth capabilities of herbaceous species that provide important winter forage for wildlife species (Augustine and McNaughton 1998). Under this alternative, continuation of high levels of herbivory in these vegetation types may reduce herbaceous production and possibly lead to altered communities (Singer et al. 2002). Consumption rates of herbaceous vegetation are considered to be extremely high, with annual herbaceous offtake rates reported to be 55% in riparian and 60% in upland habitats (Singer et al. 2002). In similar systems, herbaceous vegetation cannot withstand offtake rates at or above 60%.

Offtake at these levels has resulted in an 18% to 29% reduction in herbaceous production in riparian communities on the core winter range. However, elk grazing may have greater effects when precipitation is average or below average, as grazed sites in years with above-average precipitation had higher levels of production compared to ungrazed sites (Zeigenfuss et al. 2002). Modeling results predict little effect of the continuation of a high level of elk herbivory over the next 20 years on herbaceous biomass (Coughenour 2002). However, the model did not take into account elk densities and distribution. Therefore, the current elk population level and over-concentration of elk on the primary winter range with resultant high levels of elk herbivory would probably have a greater-than-predicted effect on herbaceous production in areas of the primary winter range. The high level of consumption has not altered herbaceous coverage on the primary winter range, but comparison with consumption rates in similar type ecosystems indicates that herbaceous communities on the primary winter range may not be able to be maintained under such grazing pressures (Monello et al. 2005).

Continuation of the current level of elk herbivory under this alternative would not be expected to have large-scale effects on plant species richness or biodiversity in upland and riparian herbaceous communities (Schell and Stohlgren 1997, Stohlgren et al. 1999, Zeigenfuss et al. 1999, Zeigenfuss et al. 2002, Singer 1995, Singer et al. 2002). Singer (1995) did not observe any differences in the number of grass or forb species inside and outside exclosures. However some changes within the habitat did occur as browsing has been found to cause increases or decreases in the cover of some individual species (Singer 1995, Zeigenfuss et al. 1999). In grasslands, elk herbivory has resulted in *Carex* spp. More than doubling in ungrazed areas (Zeigenfuss et al. 2002). In riparian areas, grazed sites had more goldenrod species (*Solidago* spp.) and ungrazed sites had more bluebell (*Mertensia retens*) after four years (Singer et al. 2002).

Although large-scale changes in plant richness or diversity would not occur, the adverse effects of elk herbivory on herbaceous plant growth and production over the life of the plan would continue to have long-term, moderate, adverse effects in areas of the elk primary winter range where concentration of elk would remain high in both the summer and winter seasons.

Herbaceous vegetation on the primary summer range would be expected to experience similar effects from elk herbivory as described above, but to a lesser extent. The primary summer range is much larger, elk densities are lower, and forage availability is higher due to the summer growing season. As a result, the long-term, adverse effect that elk herbivory would have on

riparian and upland herbaceous plant production, growth, and individual species abundance would be minor.

Bitterbrush and Sagebrush Upland Shrubs

Bitterbrush and sagebrush upland habitats are important forage for mule deer in the park and provide habitat for many bird and small mammal species (see *Wildlife* section of this chapter). High levels of herbivory that would continue under this alternative have affected bitterbrush and sagebrush production, morphology, and cover as well as species composition and abundance.

The continued level of herbivory under this alternative would continue to negatively affect total estimated annual shrub production and growth. Over the long term, studies indicate that herbivory would affect upland shrub production as bitterbrush protected from grazing increased over a 25-year period between 12% and 37% depending on amount of shrub originally present (Gysel 1960), and after 35 years, sagebrush current annual growth increased by 67% (Schoenecker et al. 2002).

Shrub volume and canopy would also be reduced in localized areas of high elk herbivory on the primary winter range under this alternative. Over a 35-year period when sagebrush was protected from elk herbivory, shrub volume and canopy increased by 300% and 178%, respectively (Singer et al. 2002).

Over the 20-year life of this plan, elk herbivory at high levels would be expected to continue to reduce bitterbrush and sagebrush production, abundance, and structure in localized areas to a moderate degree on the primary winter range. Alternative 1 would result in long-term, moderate, adverse effects on bitterbrush and sagebrush production and volume in localized areas of the primary winter range.

Elk herbivory under this alternative would not be expected to produce large-scale changes in species abundance or species diversity, although localized changes in habitat would occur as a result of continued high levels of elk herbivory. Elk herbivory has resulted in 14% and 56% increases in the height of bitterbrush and sagebrush habitat, respectively, as well as a 24% to 32% increase in the percent cover of grasses over the long-term. Increases in height of bitterbrush may have been a result of decreased use of by mule deer in both vegetation types (Zeigenfuss et al. 1999). In upland bitterbrush sites, percent cover of prairie sage (*Artemisia ludoviciana*) and sulphur buckwheat (*Eriogonum umbellatum*) in grazed sites was reduced after four years (Zeigenfuss et al. 1999). These changes in individual species abundance would continue to occur under this alternative without changes in the level of elk herbivory. Elk herbivory effects on individual species abundances and habitat changes within bitterbrush and sagebrush habitat would continue to have long-term, localized, minor, adverse impacts on the primary winter range.

Subalpine and Alpine Vegetation

Subalpine and alpine riparian and upland willow on the elk primary summer range cover 2,236 acres. Limited data exist for elk herbivory effects on willow in this area; however, anecdotal observations by park staff and researchers have led to growing concern that elk are adversely affecting willow in this area much as described above for the primary winter range. Recent analysis of 12 transects in subalpine and alpine plant communities collected over varying intervals between 1971 to 1996 found that flat-leafed willow showed a 48% cover and 37% height decline, and that short-fruit willow showed a 70% cover and 40% height decline over the 25-year period (Zeigenfuss 2005). These trends do not definitively correlate with elk herbivory; however, they do support general observations by park staff and researchers. Some evidence

exists suggesting that elk are affecting willow morphology in the alpine, as willows protected from herbivory in the alpine were shown to be one-third taller than those that were grazed over an eight-year period (Stevens 1980b). The adverse effects on willow in this area over a 20-year period could range up to major.

Subalpine and alpine herbaceous vegetation are unique in that they can grow in very harsh climatic conditions. Species of plants in these environments are often considered sensitive to disturbance, as they are slow to recover due to the short growing season and low average temperatures. Limited research is available to assess the impacts of elk use of subalpine and alpine areas. In the past, elk use of the tundra has been shown to be minimal; however, there have been indications that various species of grasses (*Poa* spp.) have been heavily used. Data also indicated a trend toward less ground cover in tundra turf areas as all major cover species lost cover and frequency of occurrence in localized areas (Stevens 1980b); however, this was not quantified. Other studies, in contrast, have not indicated any lasting effects by elk (Marr and Willard as cited in Stevens 1980b). These studies do not indicate that elk herbivory is having long-term, community level impacts on subalpine and alpine herbaceous vegetation. The localized, adverse effects of elk herbivory would be minor and long term, due to the slow recovery of these vegetation types to disturbance.

Exotic Plants

Elk herbivory can have indirect effects on vegetation composition and abundance by increasing the amount of bare ground due to trampling and grazing, which reduce native plant cover and distribution. Increases in bare ground could result in increases in exotic plants in the area as exotic species thrive in disturbed areas where there is less or no competition from native plants. Only minor, localized increases in bare ground have been related to elk grazing on the primary winter range (see "Soils" section in this chapter), and no evidence shows that elk herbivory is increasing exotic plant species abundance or coverage on the elk range (Singer et al. 2002, Zeigenfuss et al. 2002). Landscape analyses have also failed to find evidence that grazing increases the spread of exotic plant species in the park or other Rocky Mountain grasslands (Stohlgren et al. 1999). A 54% increase in the exotic grass timothy (*Phleum retense*) was observed in park meadows from 1968 to 1992 (Zeigenfuss et al. 1999). However, the study could not confirm that this increase resulted in a decline of native vegetation (Zeigenfuss et al. 1999). After 16 years, Canadian thistle has increased by 57% in disturbed areas of the park. Although this increase cannot be attributed to elk, by nature exotic plants increase in disturbed areas, and continued degradation of montane riparian willow communities on the elk range, increase the potential for Canadian thistle invasion (McLendon 1996). The adverse impact of exotic plants on native vegetation on the elk range as a result of elk herbivory under this alternative would continue to be long term, localized, and negligible to minor.

Cumulative Impacts

Previous impacts on vegetation on the elk range were due to anthropogenic disturbances such as livestock grazing and haying, water diversions and irrigation, cultivation of grassland meadows, reduction of beaver populations, flood events, fire suppression, and recreational and park development activities that affected aspen and montane riparian willow in particular but other vegetation as well. The condition of aspen, willow, upland shrub, and herbaceous vegetation on the elk range has experienced moderate-to-major adverse effects as a result of these past disturbances. In other areas of the park, vegetation has also been affected by past development and use, although to a lesser degree. These past anthropogenic disturbances in other areas of the park varied considerably as to type, intensity, and duration before and after the park was

established. The adverse effects of these disturbances on aspen, willow, upland shrub, herbaceous, and alpine vegetation have ranged from minor to moderate.

Fire management in the park after 1970 included the use of prescribed fire or the allowance for naturally caused fires to occur in designated areas of the park. These actions would not occur in the aspen, willow (see discussion in the analysis of Alternative 1), or bitterbrush habitat on the elk range due to the high level of ungulate herbivory.

In the park, it was found that total shrub canopy area and volume can recover after a burn in the absence of grazing, or if the levels of grazing are not at the current high levels (Nescavil 2003). However, bitterbrush and sagebrush upland shrubs, which occur predominantly on the elk range, would not be treated with prescribed fire due to the detrimental effects that high levels of elk and deer browsing would have on the vegetation post-burn. Intense ungulate herbivory following fire may result in a net loss of shrub habitat in the park. A wildfire in this habitat would have a high potential for loss of large portions of the upland shrub due to the continued high level of elk and deer herbivory that would occur following the fire, a major, long-term, adverse effect. The use of prescribed fire in portions of the montane riparian willow, aspen, and shrub habitat that exists outside the elk range in the park would benefit this vegetation in localized areas, as regeneration would improve and growth and production of these vegetative types would increase. Because of the small area of effect, the benefits would be long term and minor.

Pollution generated in areas outside the park results in nitrogen deposition within the park in rain or snow or as dry particles. It has been estimated that current nitrogen deposition levels in the park are 20 times higher than natural levels (NPS 2005g). High elevation areas of the park have been changed by the effects of nitrogen deposition (Barons et al. 2000, Burns 2003). Plants in the alpine have evolved under very low nitrogen conditions and therefore are more adapted to nitrogen limitation rather than nitrogen enrichment (Baron et al. 1994). Increases in nitrogen in the alpine result in rapid growth of grasses, which out-compete alpine plants. A shift from flowering alpine plants to grasses and sedges in the park could result in the potential decline or loss of alpine wildflower communities, reducing plant diversity (Blett and Morris 2004). Continued nitrogen deposition in the alpine areas of the park would result in long-term, major, adverse impacts on alpine vegetation.

Recent management plans have been implemented to protect vegetation within the park. The vegetation restoration management plan and the resource management plan establish broad objectives and a framework for managing vegetation within the park. The vegetation restoration plan in particular sets forth management actions to be implemented to restore vegetation in areas of past anthropic disturbance. These restoration efforts would recover abandoned roads and trails in the park, stabilize sites to minimize deterioration due to exposed soils and erosion, control the establishment of invasive species, and facilitate the recovery of late successional communities that would have been on the site prior to any disturbance through active restoration methods. In addition, an invasive species plan was developed to control invasive plants existing in the park and to prevent the establishment of new invasive species through establishment of management guidelines. The restoration of vegetation in the park to restore ecological integrity and the control and prevention of invasive plant species would provide long-term, minor-to-moderate, beneficial effects on vegetation throughout the park, depending on the size of the area and the rarity and sensitivity of the vegetation type being restored or treated.

Trails maintenance and management plans and a backcountry management plan have been developed that would have long-term benefits to vegetation. Establishing a designated trail system and defining appropriate backcountry use and proper maintenance of trails within the park and on the elk range would reduce off-trail use and resultant trampling and decline or loss of vegetation and would limit soil erosion and increased bare ground. These plans offer a long-term,

negligible-to-minor benefit to most vegetation; however, in alpine areas where vegetation is slow to recover from disturbance, establishment of designated trails provides moderate benefits.

Future development of one-mile of the Continental Divide National Scenic Trail within the Kawuneeche Valley would result in the long-term decline or loss of montane riparian willow in this area. The adverse effects due to the small scale of the project would be minor.

Short-term adverse impacts would occur to vegetation as a result of management activities that occur within the park to maintain trails, treat invasive plants, and implement fire management actions. Access to sites to implement actions and the presence of personnel would cause trampling and decline or loss of vegetation. Chemical, cultural, biological, and mechanical techniques to control invasive plants would result in limited non-target damage to native plants. In non-alpine areas, these actions would be short term and negligible to minor, as most vegetation would recover within a few years and mitigation measures would restore disturbed areas where necessary. In alpine areas, the effects would be long term.

The continuation of high elk herbivory levels as a result of a high population size, high elk densities, and limited dispersal under Alternative 1 would continue to have moderate-to-major, adverse effects on vegetation on the elk range, particularly on the primary winter range and in the Kawuneeche Valley. The impacts of elk herbivory on the elk range outweigh beneficial management actions that would occur there. The overall cumulative adverse effects on vegetation on the elk range therefore would be long term and moderate to major. In other areas of the park, the effects of continuing the current management of elk and vegetation on the elk range would have little to no effect on vegetation. Management plans that would result in restoration of areas of the park that were previously disturbed, restoring fire as an element of the ecosystem that is necessary for maintenance of healthy vegetative communities, and providing protection to vegetation by limiting activities and use that disturb areas would offset to a large degree the adverse effects of other actions and would result in minor-to-moderate, beneficial, cumulative effects.

Conclusion

Continuation of high levels of elk herbivory due to a large elk population and high elk densities would continue to adversely affect the growth, reproduction, abundance, and distribution of vegetation on the elk range and continue to result in community level changes. There would be a continued inability of aspen and willow to regenerate, resulting in continued reductions in stand structure and vigor, dramatic declines in cover and distribution, and further conversion of these important habitat types to grassland in portions of the elk range.

Aspen

Aspen on the elk range may be permanently lost if the current level of elk herbivory continues. High levels of elk herbivory that are expected to continue under Alternative 1 would continue to reduce the ability of aspen to regenerate. Aspen stands would continue to become increasingly composed of taller, older trees that over time would begin to die, reducing the size and distribution of stands in areas of the elk range. Because of the rarity of aspen within the range, the continued high-level grazing by elk would have a long-term, major, adverse impact on aspen. Fire is not necessary for the persistence of aspen stands on the elk range; however, it can stimulate regeneration. An inability to use prescribed fire on the elk range under this alternative would be a major, long-term, adverse effect.

Montane Riparian Willow

High levels of elk herbivory and greater depth to ground water under this alternative would continue the conversion of montane riparian willow habitat to grassland and from taller to shorter willow areas on the elk range. High levels of elk herbivory would continue to affect willow reproduction and seedling establishment. As a result, montane riparian willow cover on the elk range would continue to decrease. Under Alternative 1, the continued degradation of montane riparian willow would result in long-term, major, adverse impacts on willow on the elk range. The continued inability to use fire to stimulate regeneration would have long-term, major, adverse effects on willow on the elk range.

Upland and Riparian Herbaceous Plants

Herbaceous species are important winter forage for wildlife species. Continuation of high levels of consumption by elk in upland and riparian herbaceous communities would result in moderate levels of reduction in annual aboveground production, although large-scale effects on plant species richness or biodiversity in upland and riparian herbaceous communities would not be expected. The adverse effects of elk herbivory on riparian and upland herbaceous vegetation would be long term and moderate in areas of the primary winter range where elk concentrate and less in other areas of the range where elk densities are less and forage availability is higher.

Bitterbrush and Sagebrush Upland Shrubs

Continued high levels of elk herbivory in upland shrub habitat would result in a reduction in annual biomass, shorter shrub heights, and decreased shrub volume and canopy, particularly in areas of the core winter range where elk densities are excessive. In these areas, the long-term effects on shrub species would be moderately adverse. Large-scale shifts in species abundance and species diversity would not occur, although changes in individual species abundance would continue to occur, resulting in long-term minor, adverse impacts on the primary winter range.

Subalpine and Alpine Vegetation

Under Alternative 1, the continued reduction in the abundance, competitive ability, and survivorship of willow in the subalpine and alpine areas of the primary summer range would range up to major over a 20-year period.

In herbaceous habitats, elk herbivory would reduce native plant species cover and abundance; however, community-level changes in vegetation would probably not occur. The adverse effects of elk herbivory on subalpine and alpine herbaceous vegetation that would continue to occur in areas would be minor and long-term, as these vegetation types are slower to recover from disturbance.

Exotic Plants

There has been no evidence that elk herbivory is increasing exotic plant species abundance within the elk range; however, continued degradation increases the potential for invasion and spread of exotic plants. The long-term, adverse effects of exotic plant species as a result of elk herbivory would be negligible to minor.

Cumulative effects on the elk range from past anthropic disturbance and continuation of high levels of elk herbivory proportionately influence vegetation to a greater degree than do management plans to restore and protect the vegetation. The cumulative, adverse effects on

vegetation on the elk range therefore would be long term and moderate to major. In other areas of the park, the effects of continuing the current management of elk and vegetation on the elk range would have little to no effect. Management plans to restore vegetation in the park would offset, to a large degree, actions that result in short- and long-term, adverse effects and would result in minor-to-moderate, beneficial cumulative effects.

Since Alternative 1 would not reverse the expected long-term, continued degradation of montane riparian willow and aspen as a result of high levels of elk herbivory due to a large elk population and high elk densities, it is expected that impairment of vegetation, particularly aspen and montane riparian willow communities, would occur over the long term.

Alternative 2

Aspen

Under this alternative, up to 160 acres on the primary winter and summer ranges would be fenced and would remain fenced over the life of the plan. When elk grazing is eliminated, aspen have been shown to successfully regenerate, with multiple age classes of aspen present as well as more live branches and fewer dead branches. In comparing grazed versus ungrazed plots, the stocking rates inside and outside exclosures averaged 637,000 and 123,000 suckers/mile^2, respectively, and the ratio of live to dead suckers was approximately 16 time higher inside exclosures. The ratio of live to dead trees was also found to be twice as high for stands that are not subject to grazing compared to grazed areas (Baker et al. 1997). When grazing was eliminated, suckers were able to survive to reach heights above eight feet, the height below which elk browsing is most intense. As a result, suckers could survive to sapling and tree size (Baker et al. 1997).

Increased aspen regeneration on the elk range would result in increased aspen stand size and cover. Modeling has indicated that once aspen are protected from elk grazing pressure, aspen cover increases markedly. When aspen are fenced over a 20-year period, the canopy cover is projected to increase by nearly 20% (Coughenour 2002).

Protection of aspen with fences on the elk range under this alternative would result in increased regeneration, as suckers could develop into saplings and could then reach mature tree size. With increased regenerative ability, the complexity of stands would increase with multiple age classes persisting, and overall stand sizes would increase across the landscape. Because of the rarity of aspen on the elk range, the protection provided by fences that would prevent the decline or loss of aspen stands, allow complete aspen recovery, and bring aspen on the elk range within the natural range of variability, which would represent a long-term, major, beneficial effect.

Under this alternative, once stands are protected from high levels of herbivory, vegetation management actions (i.e., mechanical stem removal and prescribed fire) may be implemented to further stimulate regeneration. Aspen on the elk range grasslands are not successional to conifers, and therefore do not require fire to regenerate. Light surface burns can stimulate sucker production by allowing more solar radiation to warm the mineral soil (e.g., Romme et al. 1995), and the vegetation that is burned provides a nutrient pulse for new suckers (Sheppard 2001). Mechanical removal of overstory stems in aspen stands can result in successful regeneration (Sheppard 1996). Using large machinery to fell aspens has been shown to produce a high number of sprouts. When stumps are removed, lateral roots are isolated, which deprives them of any residual hormones to inhibit root growth that would be left if trees where felled by chainsaws (Sheppard 1996). These techniques to stimulate new growth of aspen on the elk range would have long-term, major, beneficial effects on the overall improvement of aspen on the elk range.

Montane Riparian Willow

Quicker reduction in the elk population and management actions to reduce densities would increase seedling establishment and seedling survival on the elk range. As the number of elk and grazing pressure decrease quickly under this alternative, montane riparian willow on the primary winter range that have been in poor condition would be able to reach maturity, and seed production on the range would increase. As a result, seed rain density within the range would be expected to increase, with a wider distribution of seed-producing willow stands on the range (Cooper et al. 2003).

As montane riparian willow would increase on the elk range, beaver would be expected to naturally recolonize areas on the elk range, or they could be reintroduced into areas once tall willow patches of 10 acres or more become established. An increase in beaver would increase the reproductive capabilities of willow either directly through vegetative propagation or indirectly through creating appropriate sites for seedling establishment (Cooper et al. 2003, Baker et al. 2005, reviewed in Monello et al. 2005). Beaver would be expected to increase the amount of surface water on the elk range and improve groundwater recharge (see "Water Quality and Hydrology" section of this chapter) and provide improved habitat over a larger area for willow establishment both naturally and through willow replanting that would occur under this alternative if needed. Montane riparian willows that are improving as a result of improved water conditions on the elk range would benefit further as a result of the large reduction in grazing pressure, which would result in increased willow reproduction, growth, and survival over nearly 2,400 acres of the elk range. These effects would be most prominent on the elk range where high elk browsing, reduced surface waters, and low beaver populations have severely depressed montane riparian willow growth.

A reduction in elk numbers and densities under this alternative would result in an increase in willow production and height on the elk range and thus an increase in cover over the landscape. This alternative would achieve meaningful increases in willow height or production across the elk range, lowering elk consumption rates below 27% or elk densities below 83 elk per square mile (Singer et al. 2002). In areas of the core winter range, reduced elk numbers and focused management actions to increase redistribution and movement of the population in this severely degraded area may result in even lower elk consumption rates, 21% or less, to allow optimal willow growth and size in the presence of elk herbivory. This would be an approximate 22% decrease in average use from conditions described in Alternative 1 on the core winter range. Monitoring of the montane riparian willow condition and responsiveness to adaptive management techniques would determine what consumption rates and/or densities are most appropriate for various locations on the elk range to achieve management objectives.

Productivity of willow would increase on the elk range with reduced elk herbivory levels. When elk are excluded from foraging on montane riparian willow, (short-term (four-year) increases in production have ranged from 18% to 66% (Schoenecker et al. 2004, Zeigenfuss et al. 2002), and long-term (35-year) increases have been nearly 100% (Schoenecker et al. 2004).

Reduced elk herbivory that would occur under this alternative would result in improvements in the growth and size of the montane riparian willow on the elk range. Short-term responses to protection from grazing have resulted in canopy volume, height, and stem density increases of 66%, and in long-term increases of up to 100% (Schoenecker et al. 2004). Willow stem height and densities can dramatically increase, as studies have shown these to have increased by 244% and 265%, respectively (Singer et al. 2002).

With elk numbers reduced to the lower end of the natural range and improvement of the water table, modeling predicts that over the next 20 years, montane riparian willow cover on the core

winter range would increase from approximately 22% cover under Alternative 2 to approximately 42%. Reducing elk to the lower end of the natural range would reduce herbivory to a sufficient degree to allow short willow on rewatered sites to withstand herbivory (Coughenour et al. 2002). However, the modeling only considered reduction in elk numbers and not changes in elk densities or distribution. With this alternative, aversive conditioning and herding techniques to prevent elk from concentrating, particularly within the primary winter range, would result in larger increases in cover and willow height.

Because a low level of herbivory would continue to occur under this alternative, it is not expected that the same level of improvements in montane riparian willow growth, production, and distribution as shown when elk are completely, unnaturally, excluded would occur under this alternative. However with implementation of monitoring of vegetation response and of adaptive management to continually redistribute and move the population to prevent concentrating and over-grazing, willow restoration on the elk range would be expected to approach levels that are described in these studies to a large degree across a large area of the elk range. Community level changes would occur as montane riparian willows would transition from shorter to taller plants and would replace herbaceous vegetation as willow abundance, competitive ability, and survivorship across the elk range would improve.

With the decreased elk population and increased distribution that would occur under this alternative, montane riparian willow on the elk range would recover across the landscape in a patchy distribution that would be representative of natural conditions compared to alternatives where fences would be used (Alternatives 3 and 4). Effects would be expected to be greater on the primary winter range, particularly the core winter range, as management actions to redistribute elk would provide the greatest benefit to that degraded area of the range, resulting in long-term, major, beneficial effects.

Once monitoring determines that montane riparian willow on the elk range is adequately protected from elk herbivory (i.e., offtake levels are low enough for willow to withstand grazing pressures and still reproduce) and that suitable willow habitat exists, vegetative restorations techniques such as active willow replanting, prescribed fire, or mechanical thinning activities would be used to improve willow distribution, remove decadent willow stems, and stimulate resprouting in areas where hydrologic conditions are suitable to support willow. Fire has not been shown to be necessary for willow regeneration; however, it can speed regenerative processes (Baker et al. 2005). Use of vegetation recovery methods under this alternative would have long-term, minor, beneficial effects on montane riparian willow on the elk range.

Although the level of competition between elk and moose is not completely understood, the large and quick reduction in elk numbers to the low end of the natural range would be expected to result in a subsequent increase in the moose population on the primary summer range. There would be a number of years before the reaction in the moose population would be fully realized (see “Other Wildlife Species” section of this chapter). It is uncertain how large the response in the moose population would be and therefore difficult to assess the level of indirect effect on montane riparian willow. However, moose feed predominantly on montane riparian willow and therefore it is expected that benefits from elk management actions would be offset to some degree.

Upland and Riparian Herbaceous Plants

Under this alternative, the high level of elk consumption (>55%) of upland and riparian herbaceous vegetation that occur, particularly on the primary winter range, would be reduced. The faster reduction in the level of consumption by elk would increase herbaceous biomass in a

short period. When montane riparian herbaceous vegetation was not subjected to grazing, biomass increased by 30% after four years of protection (Zeigenfuss et al. 1999). However, with the increase that would occur in montane riparian willow, riparian herbaceous vegetation would be expected to decrease slightly over time.

Upland herbaceous vegetation on the primary winter range would gradually increase by approximately 1% to 3% over the next 20 years with the elk population maintained at the lower end of the natural range (Coughenour 2002).

The reduction in elk numbers and density would change the cover of individual species but would not result in large-scale effects on species abundance, biodiversity, or composition in riparian and upland herbaceous communities. Studies have not observed any differences in the cover or number of grasses and forbs inside and outside grazing exclosures, although cover of individual species increased or decreased (Singer 1995, Zeigenfuss et al. 1999).

Because elk herbivory would still occur, production increases and changes in individual species abundance on the primary winter range would not be as great as was found when elk and deer were unnaturally excluded. However, maintaining the elk population at the lower end of the natural range over a 20-year period with decreased densities as a result of lethal reduction activities and redistribution methods would produce results approaching these levels. This would result in a long-term, minor-to-moderate benefit to upland herbaceous vegetation on the elk range. In montane riparian willow areas, the conversion from grassland back to montane riparian willow shrub habitat would have a minor-to-moderate, adverse effect on herbaceous vegetation; however, this conversion would be more reflective of natural conditions.

Bitterbrush and Sagebrush Upland Shrubs

Fast reductions in elk numbers and densities would affect bitterbrush and sagebrush biomass, morphology, cover, and habitat composition as a result of individual species abundance changes. Shrub production and current annual growth in the long-term would increase as a result of reductions in elk herbivory. When elk were excluded from grazing for 35 years, annual shrub production increased by 67% (Schoenecker et al. 2002). Shrub volume and canopy would also be increased in areas on the primary winter range if elk numbers and densities were reduced. Over a 25-year period, bitterbrush that was protected from grazing increased between 12% and 37%, depending on the amount of brush originally present (Gysel 1960). Over a 35-year period, shrub volume and canopy increased by 300% and 178%, respectively (Singer et al. 2002). Over the long term, large reductions in elk herbivory on the primary winter range would result in moderate beneficial effects on production, volume, and canopy in sagebrush and bitterbrush communities.

Elk herbivory has been shown to increase the height in sagebrush and bitterbrush communities by 14% to 56%. However, these results were attributed to a decreased use of the vegetation by deer (Zeigenfuss et al. 2002).

Large-scale shifts in plant species biodiversity in these habitats are also not expected to occur with reductions in elk herbivory levels, although changes in individual species could occur. When grazing pressure is eliminated in upland bitterbrush sites, cover of prairie sage and sulphur buckwheat in ungrazed sites increased after four years (Zeigenfuss et al. 2002). These changes in species abundances would have minor, beneficial impacts on the primary winter range.

Under this alternative, the large and quick reduction in elk numbers to the low end of the natural range would be expected to result in a subsequent increase in the mule deer population on the elk range. There would be a number of years before the reaction in the deer population would be fully realized. With a large increase in the deer population, the minor-to-moderate benefits to

bitterbrush and sagebrush communities that would result from a large reduction in elk herbivory would be expected to be largely offset by increased deer browsing (see *Wildlife* section of this chapter). The diet of mule deer consists largely of upland shrubs, such as sagebrush and bitterbrush (Kufeld et al. 1971). With the potential for large increases in the mule deer population as a result of reduced competition with elk and with upland shrub being the main component of mule deer diet, the indirect effects on bitterbrush and sagebrush of large elk reductions would be long term, moderate to major, and adverse as deer browsing would increase, particularly on the elk primary winter range. Effects on the primary summer range would be adverse, long term, and minor to moderate.

Subalpine and Alpine Vegetation

Large elk reductions would have beneficial effects on subalpine and alpine riparian and upland willow and herbaceous vegetation. Reduced levels of herbivory would have the same long-term, major, beneficial effects as for montane riparian willow on the primary summer range.

Reducing elk herbivory through reductions in population size and densities by redistributing elk in the subalpine and alpine areas would increase cover and frequency of some species of grasses in localized areas; however, no community-level effects would occur. The reduction in elk herbivory that occurs would result in long-term, minor, beneficial effects on subalpine and alpine herbaceous vegetation.

Exotic Plants

With large reductions in elk numbers and densities, there would be less bare ground created and therefore less disturbed areas for establishment of exotic plants. There has been no evidence that elk herbivory in the park results in increased exotic plant species abundance. However, under this alternative, the recovery of native vegetation on the elk range would reduce the further potential for spread or invasion of exotic plants. The long-term benefit of a reduction in the potential for exotic plant species infestation would be negligible to minor.

Management Activities

Management actions to install fences to protect aspen, redistribute elk, install a capture facility, and remove carcasses would result in localized impacts on vegetation as a result of trampling and individual plant removal. Under this alternative, fences would be installed to protect up to 160 acreas of aspen in various-sized patches on the elk range. This would result in localized, adverse effects from construction, as plants would be removed to install posts and the presence of machinery and personnel would cause local trampling and loss of individual plants. (The benefits to aspen as a result of being fenced have been discussed above.) Herding could be used to direct elk movements to capture facilities. Herding would be conducted using trained herding dogs, people on foot, or riders on horseback. This would result in impacts on vegetation as a result of trampling not only from the activity of people and horses, but also as a result of the concentrated movement of the elk being directed to a capture facility or from the primary winter range to the primary summer range. Use of a temporary capture facility would result in decline or loss of vegetation within a small area from trampling by elk that are herded into the facility. Carcass disposal would require elk carcasses to be dragged or carried out of a treatment area. This would result in the localized trampling and loss of individual plants.

Personnel accessing sites via trucks, off-road vehicles, or horses would result in trampling and decline or loss of vegetation in the local area. Actions that would occur in winter would have less

effect, as the plants are in senescence and the ground may be frozen. Where actions have resulted in the decline or loss of vegetation and exposure of bare ground, mitigation measures would be employed to reseed areas with appropriate native vegetation.

Management activities would not result in population loss or community levels effects. The adverse effects would be short term, localized, and minor during the reduction phase of the plan, when a greater number of elk are being lethally removed and management activities are more intense. In the maintenance phase, when management actions are less intense as a lower number of elk are being removed, there would be no need for a capture facility and a lower number of carcasses would need to be removed; therefore, the impacts would be negligible to minor. In alpine areas where vegetation is slower to recover, the impacts would be long term. To reduce the level of impact in this sensitive habitat, management activities would not involve the use of horses or off-road vehicles, resulting in localized, minor, adverse effects.

Cumulative Impacts

The cumulative actions that affect vegetation would be the same as those described under Alternative 1.

The large and rapid reduction in the elk population to the lower end of the natural range and the increased distribution would result in large reductions of elk herbivory and its impacts on vegetation. This would result in moderate-to-major benefits on aspen, willow, and herbaceous vegetation on the primary winter range and in the Kawuneeche Valley and minor-to-major benefits to subalpine and alpine vegetation on the primary summer range. The beneficial effects of Alternative 2 on vegetation on the elk range combined with beneficial effects of management plan actions to restore and protect vegetation would have a moderate-to-major, long-term, cumulative benefit on aspen, willow, herbaceous, and alpine vegetation.

In other areas of the park, the effects of elk and vegetation on the elk range would have little to no effect on vegetation. Management plans that would restore areas of the park that were previously disturbed, restore fire as a necessary element of the ecosystem, and protect vegetation by limiting activities and use that disturb areas would offset to a large degree the adverse effects of other actions and would result in minor-to-moderate, beneficial, cumulative effects.

Conclusion

The rapid reduction in elk numbers, the increased distribution and migration of the population, and the protection of aspen stands of the elk range with fences would result in large reductions in elk herbivory on the elk range in a short period of time. This would result in increased growth, production, abundance, and distribution of vegetation on the elk range and would facilitate community level changes toward a more natural condition. This alternative would prevent the loss of aspen and willow on the elk range and result in increased stand size, structure, vigor, and distribution of these important habitat types over large portions of the elk range.

Aspen

Protection of the aspen with fences on the elk range to prevent elk herbivory would result in increased aspen regeneration, increased stand size and complexity, and increased cover. Because of the rarity of aspen stands on the elk range, the protection provided from elk herbivory under this alternative would allow recovery of aspen on the range, which would be a long-term, major, beneficial effect. The ability to use fire and mechanical vegetation removal actions within aspen

stands once aspen have recovered would be a major, long-term benefit, as these methods would improve regrowth of aspen; however, they are not necessary for aspen regeneration.

Montane Riparian Willow

With a large reduction in elk population, increased dispersal of the population, and increased water table as a result of beaver recovery or reintroduction, willow reproduction, seedling establishment, and distribution on the elk range would increase. Lower levels of elk browsing would result in large increases in willow production, height, stem density, and canopy volume. The montane riparian willow would transform from shorter willow to taller willow, and montane riparian willow would replace herbaceous vegetation. The recovery of montane riparian willow across the landscape would be patchily distributed, reflective of natural conditions. The increase in abundance, competitive ability, and survivorship of montane riparian willow would prevent the conversion of willow to grassland in areas of the elk range, resulting in long-term, major, beneficial impacts, particularly in the core winter range. The benefits to willow would be offset to some degree due to the indirect effect of an increase in moose populations on the primary summer range. The use of vegetation recovery methods such as active willow planting, prescribed fire, and mechanical thinning to improve willow distribution and regeneration would have long-term, major, beneficial effects.

Upland and Riparian Herbaceous Plants

Rapid reductions in the elk population and increased elk distribution would result in increased upland herbaceous biomass and individual species abundances; however, large-scale effects on plant species abundance, biodiversity, or composition would not be expected. On the elk range, the long-term beneficial effects would be minor to moderate. The conversion of herbaceous habitat to montane riparian willow shrub as willow coverage increases would represent a minor-to-moderate, adverse effect on herbaceous vegetation; however, this would reflect natural conditions.

Bitterbrush and Sagebrush Upland Shrubs

A large reduction in the elk population along with increased distribution would result in increased annual biomass, shrub heights, shrub volume, and canopy, particularly in areas of the core winter range where elk densities are excessive. The long-term, beneficial effects on shrub species would be moderate. Large-scale shifts in species abundance and species diversity would not occur, although increases in individual species abundances would occur, resulting in long-term, minor, beneficial effects on the primary winter range. With a large decrease in the elk population, the mule deer population and thus herbivory on upland shrubs would be expected to increase dramatically. This would offset the benefits of reduced elk herbivory and result on long-term, moderate-to-major, adverse effects, particularly in areas of the primary winter range.

Subalpine and Alpine Vegetation

Large reductions in the elk population and increased dispersal would reduce elk herbivory in subalpine and alpine riparian and upland willow and herbaceous habitats, resulting in increases in native plant species cover and abundance in localized areas. The reduction in disturbance from elk grazing would result in long-term, major, beneficial effect on riparian and upland willow and minor benefits to herbaceous vegetation.

Exotic Plants

There has been no evidence that elk herbivory in the park results in increased exotic plant species abundance. However, the recovery of native vegetation on the elk range would reduce the further potential for spread or invasion of exotic plants. The long-term benefit of reduced elk numbers and densities on reducing the potential for exotic plant species infestation would be negligible to minor.

Management Activities

In the reduction phase of the plan, agency lethal reduction operations, herding, carcass disposal, installation of fences, and use of temporary capture facilities would result in localized trampling and loss of individual plants. The effects would be short- and long-term and minor, as the areas exposed would be reseeded with native plants. Effects would be reduced to negligible to minor during the maintenance phase of the plan, when management operations are less intense.

The large reduction in elk herbivory and protection of vegetation under this alternative in combination with plans and actions to restore and protect native vegetation would result in moderate-to-major, long-term, cumulative benefits on aspen, willow, herbaceous, and alpine vegetation. The increase in deer browsing upland shrub habitat that would occur rapidly under this alternative combined with the potential for high levels of degradation in areas where burning would occur on the elk range would have cumulative, long-term, major, adverse impacts on upland shrub vegetation. In other areas of the park, the effects of elk and vegetation management actions on vegetation on the elk range would have little to no effect. Management plans to restore vegetation in the park would off-set to a large degree actions that result in short- and long-term, minor, adverse effects and would result in overall minor-to-moderate, beneficial, cumulative effects.

Impairment of vegetation within the park would not occur under Alternative 2.

Alternative 3

Aspen

The impacts of protecting the aspen on the elk range with fences would be the same as described under Alternative 2. The increase in aspen stand structural complexity, cover, and regenerative ability on the elk range as a result of fences and use of prescribed burning and mechanical activities to stimulate regeneration would be the same as described under Alternative 2. Because of the rarity of aspen on the elk range, the protection provided by fences that would allow aspen recovery on the elk range under this alternative would represent a long-term, major, beneficial effect.

Montane Riparian Willow

Under this alternative, up to 260 acres of montane riparian willow on the primary winter range and 180 acres on the primary summer range in the Kawuneeche Valley would be fenced in a phased approach to provide protection from elk grazing effects. The amount of fenced acreage would be commensurate with levels of elk reduction. Within the fenced area, changes in the montane riparian willow would be as described under Alternative 2; however, the restoration of willow would be faster and to a greater degree, as elk herbivory would be eliminated. Within these fenced areas, beaver would be expected to recolonize or be reintroduced to the area quicker,

further increasing the potential for willow establishment on the primary winter range. Because the willow would be protected from elk herbivory quicker under this alternative, prescribed burning and thinning techniques to stimulate re-sprouting could be conducted sooner compared to Alternative 2.

Without herbivory by elk, montane riparian willow growth, canopy cover, distribution, and structure in fenced areas over the 20-year life of the plan would approach levels described in exclosure studies discussed in Alternative 2. Based on modeling, canopy cover of willow when fenced and with higher water tables would reach nearly 55%, a 30% increase over Alternative 1. Community-level changes would be more complete as willows transition from shorter to taller plants and montane riparian willow replace herbaceous vegetation due to improved willow abundance, competitive ability, and survivorship within fenced areas. Beneficial effects on montane riparian willow within fenced areas would therefore be long term and major, with complete removal of elk herbivory for the duration of fencing allowing a large area of the primary winter range to be restored. Elk herbivory is a natural component of the montane riparian willow, and excluding all elk herbivory would result in an unnatural pattern of willow recovery on the primary winter range.

Outside fenced areas, the improvements to montane riparian willow would be less and would not be evident until later in the plan. In the earlier years of the plan when elk numbers would still be relatively high, montane riparian willow outside fenced areas would be adversely affected as described under Alternative 1. Over time, as the elk population would be reduced to the higher end of the natural range and with employment of techniques to reduce densities, montane riparian willow on the elk range outside fenced areas would have somewhat increased ability to reach maturity, produce seeds, increase establishment and distribution, and increase height. Over the life of the plan, montane riparian willow on the elk range outside fenced areas would increase in abundance, and the ability of willow to compete and survive would increase. The benefits to willow on the primary summer range that would not be fenced would be offset to some degree due to the indirect effect of an increase in moose populations on the primary summer range. Because montane riparian willow recovery would not be as rapid under this alternative in unfenced areas, the recovery of beaver in unfenced areas on the primary elk range would be slower (see "Other Wildlife Species" section of this chapter). The ability to use prescribed fire or thinning techniques to stimulate re-sprouting in unfenced areas would also be delayed. Therefore, the benefits over the life of the plan to montane riparian willow outside of fenced areas on the elk range would be long term and moderate. However, applying adaptive management, with increased use of aversive conditioning in areas where elk concentrate and with the use of herding to move elk from the primary winter range in the summer, recovery of montane riparian willow across the elk range would be to the same level as described in Alternative 2.

Upland and Riparian Herbaceous Plants

Under this alternative, as elk numbers would gradually be reduced over the life of the plan to achieve an elk population at the higher end of the natural range, benefits to herbaceous vegetation on the elk range would take longer compared to Alternative 2. Because the population reduction would be gradual and fewer elk would be lethally removed annually, aversive conditioning and herding to move elk would be used more frequently under this alternative. On the primary winter range up to 260 acres of montane riparian willow habitat could be fenced. The amount of fenced acreage would be commensurate with levels of elk reduction. Within the fenced area, changes in the herbaceous vegetation would be as described under Alternative 2; however, the changes would be faster and to a greater degree, as elk herbivory would be eliminated. In these montane

riparian areas, the conversion back to willow habitat would have a minor-to-moderate, adverse effect. However, this conversion would be representative of natural conditions.

As a result, production and biomass of upland and riparian herbaceous vegetation, as well as individual species abundances, would increase, but to a lower level than described in Alternative 2, due to the larger elk population.

Outside the fenced areas, montane riparian and upland herbaceous vegetation would continue to be grazed; however use of redistribution methods would reduce densities of elk. The benefit of management actions would be slightly less than under Alternative 2 as a result of the higher number of elk and would be negligible to minor outside fenced areas.

Bitterbrush and Sagebrush Upland Shrubs

Gradual reductions in elk numbers and densities would affect bitterbrush and sagebrush morphology, cover, and habitat composition as a result of individual species abundance changes in the same way as described in Alternative 2; however, benefits would be less and would take longer to achieve. The benefits would not be as great as described in Alternative 2 because the elk population reduction would be to a higher population level at the end of the planning period. On the primary winter range, the long-term beneficial effects would minor. The gradual reduction in the elk population over the 20-year life of the plan to achieve a population of elk at the higher end of the natural range would result in a slower increase in the mule deer population and to a lesser extent than described in Alternative 2. The benefits to bitterbrush and sagebrush upland vegetation due to reduced elk herbivory under this alternative would be offset to some degree by the gradual increase in the deer population. The long-term, adverse effects would be moderate, particularly on the primary winter range, where ungulate herbivory has been more severe. Effects of an increase in the deer population on upland shrubs on the primary summer range would be adverse, long term, and minor.

Subalpine and Alpine Vegetation

Gradual reductions in the elk population and redistribution of the population would have beneficial effects on subalpine and alpine herbaceous vegetation. Reducing elk herbivory through reductions in densities and lethal reduction activities that would redistribute elk in the subalpine and alpine areas would occur less frequently under this alternative, as the number of elk removed each year would be lower than in the initial phase of Alternative 2. Because of the gradual reduction over time, elk herbivory would be higher for a longer period of time and benefits would take longer to become evident. The benefits to subalpine and alpine forbs from an increase in cover and frequency of some species of grasses in localized areas would be minor and long term.

Exotic Plants

The reduction in the potential for exotic plant invasion in elk use areas on the elk range would be the same as described under Alternative 2.

Management Activities

Under this alternative nearly four times the area of vegetation would be fenced compared to Alternative 2, which would result in minor, localized, short- and long-term, adverse effects from construction as plants would be removed to install posts and the presence of machinery and

personnel would cause local trampling and loss of individual plants. (The benefits of aspen protection through use of fences is described above.) The short-term effects of agency lethal reduction operations, herding, and carcass disposal would be the same as described above for the maintenance phase of Alternative 2, when fewer numbers of elk would be lethally removed. The adverse effects on vegetation in localized area where management actions would occur would be negligible to minor. In alpine areas, where vegetation is slower to recover, the impacts would be long term.

Cumulative Impacts

The cumulative actions that affect vegetation would be the same as those described under Alternative 2, although the adverse effects on upland shrub habitat would be moderately adverse and would take a longer time to manifest. Under this alternative, the deer population that would adversely impact upland shrub would increase gradually and to a lower population size than described in Alternative 2. Therefore, the cumulative, adverse effects of this alternative on upland shrub on the primary winter range and on bitterbrush in particular in combination with the effects of prescribed burning would be long term and moderate.

Conclusion

This alternative would result in increased growth, production, abundance, and distribution of vegetation on the elk range and would facilitate gradual, community-level changes toward a more natural condition. It would also prevent the loss of aspen and willow on the elk range and would increase stand size and structure, vigor, and distribution of these important habitat types in large fenced areas on the elk range. However, the recovery of vegetation outside fenced areas would be less than described under Alternative 2 due to the higher elk population target.

Aspen

Protecting all aspen on the elk range with fences to prevent elk herbivory would result in increased aspen regeneration, increased stand size and complexity, increased cover, and prevention of aspen loss as described under Alternative 2. Long-term benefits to aspen on the elk range from prohibiting elk herbivory would be major. The ability to use fire and mechanical vegetation removal actions within aspen stands once aspen have recovered would be a major, long-term benefit.

Montane Riparian Willow

In fenced areas of the primary elk range, montane riparian willow recovery would be more rapid than in Alternative 2 as a result of elk herbivory elimination, beaver recovery or reintroduction and the resulting increased water table levels, and the use of vegetative management tools. Increases in montane riparian willow height, volume, cover, and distribution would occur in fenced areas. Prevention of both the loss of montane riparian willow and the consequent conversion of willow to grassland in areas of the elk range would be a major, long-term benefit. Outside fenced areas on the elk range, elk herbivory would occur at a higher level compared to Alternative 2 as the population would be reduced gradually to the high end of the natural range; therefore, benefits to montane riparian willow would be less and slower to be achieved. With increased use of redistribution methods to reduce elk concentrations outside fenced areas and the potential for beaver recovery and vegetative management tools later in the plan, benefits to montane riparian willow would be long term and moderate. These benefits would be offset to

some degree due to indirect effects of an increase in the moose population on the primary summer range. With adaptive management, the level of montane riparian willow recovery would be the same as Alternative 2 and the overall long-term benefit would be major. The recovery of montane riparian willow across the landscape however would not be representative of natural conditions, as recovery would be more complete in fenced areas.

Upland and Riparian Herbaceous Plants

Gradual reductions in the elk population to the high end of the natural range and increased use of methods to redistribute elk would result in increased herbaceous production and individual species abundances, although these benefits would be achieved gradually and become evident later in the plan. As in Alternative 2, large-scale effects on plant species abundance, biodiversity, or composition would not be expected. On the primary winter range, the long-term, adverse effects on montane riparian herbaceous vegetation in fenced areas would be minor to moderate due to conversion from grassland to shrub habitat, although this would reflect natural conditions. Outside fenced areas, the long-term, beneficial effects would be negligible to minor.

Bitterbrush and Sagebrush Upland Shrubs

Gradual reductions in the elk population to the high end of the natural range and increased distribution would result in gradual increases in annual biomass, shrub height, shrub volume and canopy, and individual species abundances, particularly in areas of the core winter range where elk densities are excessive. The long-term beneficial effects on shrub species would be minor and would become evident later in the plan. With a gradual decrease in the elk population, mule deer population and thus herbivory on upland shrubs would increase gradually. This would offset the some of benefits of reduced elk herbivory and result in long-term, moderate, adverse effects, particularly in areas of the primary winter range.

Subalpine and Alpine Vegetation

Gradual reductions in the elk population to the high end of the natural range and increased dispersal would reduce elk herbivory in subalpine and alpine habitats, resulting in long-term, moderate-to-major, beneficial effects for montane riparian willow as described for montane riparian willow and localized increases in native plant species cover and abundance that would occur slowly over the life of the plan that would have localized, long-term, minor, beneficial effects.

Exotic Plants

There has been no evidence that elk herbivory results in the park in increased exotic plant species abundance. However, under this alternative, the recovery of native vegetation on the elk range would reduce the further potential for spread or invasion of exotic plants. The long-term benefit of a reduction in the potential for exotic plant species infestation would be negligible to minor.

Management Activities

Installation of fences, agency lethal reduction operations, herding, and carcass disposal would result in localized trampling and loss of individual plants. The effects would be both short term and long term and negligible to minor, as the areas exposed would be reseeded with native plants.

The cumulative effects under this alternative on the elk range from a gradual reduction in elk herbivory and protection of vegetation in combination with plans and actions to restore and protect native vegetation would result in overall moderate-to-major, long-term benefits on aspen, willow, herbaceous, and alpine vegetation. The cumulative effect on upland shrub habitat as a result of a gradual increase in deer browsing combined with the effects of burning on the elk range would be moderate. In other areas of the park, the effects of elk and vegetation management actions on the elk range would have little to no effect on other areas of the park. Management plans to restore vegetation in the park would offset to a large degree actions that result in short- and long-term, minor, adverse effects and would result in minor-to-moderate, beneficial, cumulative effects.

Impairment of vegetation within the park would not occur under Alternative 3.

Alternative 4

The changes in aspen on the elk range as a result of fencing would be the same as described above under Alternative 2.

The impacts of a reduction in elk population size and a decrease in elk densities on willow, upland and riparian herbaceous vegetation, bitterbrush and sagebrush upland vegetation, and subalpine and alpine vegetation would be similar to those described in Alternative 3. Without fences to protect montane riparian willow on the primary summer range, willow recovery in this area would be slower compared to Alternative 3. Redistribution actions would be increased in unfenced areas to reduce elk herbivory and protect willow. Benefits as a result of a smaller elk population to willow on the primary summer range would be offset to some degree due to the indirect effect of an increase in moose populations on the primary summer range. With adaptive management, the level of montane riparian willow recovery on the primary elk range would be the same as Alternative 3, with overall long-term major benefits. The reduction in bare ground as a result of elk use of an area and potential for exotic plant establishment in areas of the elk range would result in benefits to vegetation as described in Alternative 3.

Management activities would have short-term and long-term, adverse, negligible-to-minor effects on vegetation in localized area of the elk range similar to those described in Alternative 3. Under this alternative, the adverse effects of installation of fences, lethal reduction operations, herding, and carcass disposal would be the same as described for Alternative 3. Under this alternative, however, particularly during the initial phase of the plan when more elk would be treated, capture facilities may be relied upon more to administer fertility control drugs, with minor adverse effects from trampling of vegetation and exposure of bare ground. Over time, as fertility control agents are relied upon more heavily and with the potential use of multi-year fertility control agents that require treating fewer elk annually, the short-term, localized impacts that result from implementation of lethal reduction activities, removal of carcasses, and capture facilities would decrease to negligible.

Cumulative Impacts

The cumulative effects of this alternative on vegetation on the elk range and in the park would be the same as described under Alternative 3.

Conclusion

This alternative would result in increased growth, production, abundance, and distribution of vegetation on the elk range and would facilitate gradual, community-level changes toward a more

natural condition. This alternative would prevent the loss of aspen and willow on the elk range and result in increased stand size and structure, vigor, and distribution of these important habitat types in large fenced areas on the elk range. However, the recovery of vegetation outside of fenced areas would be less than described under Alternative 2 due to the higher elk population target.

Aspen

Protecting all aspen on the elk range with fences to prevent elk herbivory would result in increased aspen regeneration, increased stand size and complexity, and increased cover as described under Alternative 2. Long-term benefits to aspen on the elk range from prohibiting elk herbivory would be major. The ability to use fire and mechanical vegetation removal actions within aspen stands once aspen have recovered would be a major, long-term benefit.

Montane Riparian Willow

Montane riparian willow recovery under this alternative would be the same as described in Alternative 3. In fenced areas of the primary winter range, increases in willow height, volume, cover, and distribution would occur more rapidly. Montane riparian willow would transform from shorter willow to taller willow and would replace herbaceous vegetation, resulting in a major, long-term benefit. Outside fenced areas on the elk range, benefits to montane riparian willow would be long-term and moderate due to elk herbivory and the later establishment of beaver and ability to use additional vegetation management tools. These benefits would be offset to some degree due to indirect effects of an increase in the moose population on the primary summer range. With adaptive management, the level of montane riparian willow recovery would be the same as Alternative 2 and the overall long-term benefit would be major. The recovery of montane riparian willow across the landscape would not be representative of natural conditions, as recovery would be more complete in fenced areas.

Upland and Riparian Herbaceous Plants

Gradual reductions in the elk population to the high end of the natural range and increased use of methods to redistribute elk would result in increased herbaceous production and individual species abundances, although these benefits would be achieved gradually and become evident later in the plan. As in Alternative 2, large-scale effects on plant species abundance, biodiversity, or composition would not be expected. On the primary winter range, the long-term, adverse effects on montane riparian herbaceous vegetation in fenced areas would be minor to moderate due to conversion from grassland to shrub habitat, although this would reflect natural conditions. Outside fenced areas, the long-term, beneficial effects would be negligible to minor.

Bitterbrush and Sagebrush Upland Shrubs

The effects of elk management would be the same as described in Alternative 3. Gradual reductions in the elk population to the high end of the natural range along with increased distribution would result in gradual increases in annual biomass, shrub height, shrub volume and canopy, and individual species abundances, particularly in areas of the core winter range where elk densities are excessive. The long-term, beneficial effects on shrub species would be minor and would be evident later in the plan. With a gradual decrease in the elk population, mule deer population and thus herbivory on upland shrubs would increase gradually. This would offset some of the benefits of reduced elk herbivory and would result in long-term, moderate, adverse effects, particularly in areas of the primary winter range.

Subalpine and Alpine Vegetation

The effects of elk management would be the same as described in Alternative 3. Gradual reductions in the elk population to the high end of the natural range and increased dispersal would reduce elk herbivory in subalpine and alpine herbaceous habitats, resulting long-term moderate to major beneficial effects for montane riparian willow as described for montane riparian willow and localized increases in native plant species cover and abundance that would occur slowly over the life of the plan that would have localized, long-term, minor, beneficial effects.

Exotic Plants

There has been no evidence that elk herbivory in the park results in increased exotic plant species abundance. However, under this alternative, the recovery of native vegetation on the elk range would reduce the further potential for spread or invasion of exotic plants. The long-term benefit of a reduction in the potential for exotic plant species infestation would be negligible to minor.

Management Activities

Installation of fences, agency lethal reduction operations, herding, and carcass disposal would result in localized trampling and loss of individual plants. The effects would be both short term and long term and negligible to minor, as the areas exposed would be reseeded with native plants.

The cumulative effects under this alternative on the elk range from a gradual reduction in elk herbivory and protection of vegetation in combination with plans and actions to restore and protect native vegetation would result in moderate-to-major, long-term benefits on aspen, willow, herbaceous, and alpine vegetation. The cumulative effect on upland shrub habitat as a result of a gradual increase in deer browsing combined with the effects of burning on the elk range would be moderate. In other areas of the park, the effects of continuing the current management of elk and vegetation on the elk range would have little to no effect. Management plans to restore vegetation in the park would offset to a large degree actions that result in short- and long-term, minor, adverse effects and would result in overall minor-to-moderate, beneficial, cumulative effects.

Impairment of vegetation within the park would not occur under Alternative 4.

Alternative 5

The changes in aspen on the elk range as a result of fences and use of prescribed fire and thinning activities would be the same as described under Alternative 2.

The effects on vegetation associated with the release of wolves would be relatively small during the first phase of the alternative because only four wolves would be present in the park. Other elements of the alternative's management actions (lethal reduction, if necessary) would compensate for the small contribution of wolves in the initial stages of Alternative 5. Over time, as the wolf population in the park increased, the effects of wolves would be more fully realized with less reliance on other management tools. During all phases of the plan, wolves would be expected to effectively redistribute the elk population.

Research has found that elk population size or densities are reduced and elk decrease their use of areas that have predators (Hebblewhite et al. 2002, Ripple et al. 2001). Wolf predation models (Coughenour 2002, Garton et al. 1990, Mack and Singer 1993, Singer et al. 2003) and empirical evidence from Glacier National Park (Kunkel and Pletscher 1999) and Banff National park,

Canada (Hebblewhite et al. 2002) indicate that wolves would limit the density and size of the elk population, particularly during the winter.

Elk in Yellowstone and Banff National Parks have been shown to decrease use of aspen and willow habitat, respectively, in areas with wolves (Nietvelt 2001, Ripple et al. 2001). In Yellowstone National Park, elk affinity for aspen stands was replaced by a preference for conifer forest areas (Ripple et al. 2001, Fortin et al. 2005). In addition, research suggests that when wolves are present, elk prefer to use open areas where they can see predators from afar (Dekker 1997) and that elk may prefer to graze in grassland areas and browse on the edge, not in the middle, of willow thickets.

As a result of changes in elk habitat use, the adverse effects of ungulate grazing on the growth of plants that are the focus of this analysis would be reduced. In Yellowstone National Park, research indicates that willow and aspen in the park that experience less grazing pressure have increased in stature (Ripple and Larson 2000, Ripple et al. 2001). In other areas where wolves have been introduced, the percent browsing by elk on willow stems has declined by 92% (Ripple and Beschta 2004b). Wolves would be expected to cause similar trophic cascading effects in other vegetation types on the elk range as well by reducing the elk population, increasing elk movements, and changing elk grazing patterns.

Elk herbivory would continue on the elk range; however, elk would not concentrate for extended periods in the same habitat, facilitating the increased abundance and growth of vegetation that are the focus of this analysis. Vegetation on the elk range would recover across the landscape in a patchy distribution that would be most representative of natural conditions compared to any of the other action alternatives. The reduced elk population size and decreased elk densities would have impacts on montane riparian willow, upland and riparian herbaceous vegetation, bitterbrush and sagebrush upland vegetation, and subalpine and alpine vegetation similar to those described in Alternative 2. As in Alternative 2, as montane riparian willow would recover across the elk range, beaver recolonization or reintroduction would occur, resulting in an increased water table, and implementation of prescribed burning and thinning activities would further improve montane riparian willow establishment and growth particularly, on the primary winter range. These benefits would be offset to some degree as a result of the indirect effects of an increase in the moose population on the primary summer range.

Bitterbrush and sagebrush upland shrub vegetation would benefit as described in Alternative 2 with the decrease in elk herbivory on the elk range. Unlike Alternative 2, however, there would be no large increase in the mule deer population to offset the beneficial effects. Wolves would be expected to increase mule deer dispersal as well as reduce deer numbers (see "Other Wildlife Species" section of this chapter). As a result, long-term, moderate benefits to bitterbrush and sagebrush upland vegetation would occur, where elk herbivory levels have had greater adverse effects.

As a result of the increased elk distribution, decreased elk herbivory, and less concentrated use of areas on the elk range, the reduction in bare ground and thus the potential for exotic plant establishment in areas of the elk range would result in benefits to vegetation as described in Alternative 2.

Management activities would have short-term and long-term, adverse, negligible-to-minor effects on vegetation in localized area of the elk range. The adverse effects of installation of fences, agency lethal reduction operations, herding, capture and holding facilities, and carcass disposal would be the same as those described above for Alternative 2. Over time, as the wolf population becomes established, the need for agency elk population reduction actions, carcass removal, and

herding would diminish, and the adverse impacts associated with these activities would be reduced to short term, local, and negligible.

Cumulative Impacts

The cumulative actions that affect vegetation would be the same as those described under Alternative 2 except that the effects on upland shrub habitat would differ. Overall, the benefits to upland shrub habitat would be long term and moderate. As wolves would be permitted to use other areas of the park, increased distribution of grazers and browsers may also benefit vegetation in other locations. The degradation of vegetation as a result of herbivory has not been identified in other areas of the park as compared to what has occurred on the elk range. The overall benefit from release of wolves in the park to vegetation in the park therefore would be minor.

Conclusion

The reduction in elk numbers and increased distribution and migration of the population and the protection of all aspen stands of the elk range with fences would result in large reductions in elk herbivory on the elk range in a short time. This would result in increased growth, production, abundance, and distribution of vegetation on the elk range and would facilitate community-level changes toward a more natural condition. Because this alternative would prevent the loss of aspen and willow on the elk range and would result in increased stand size, structure, vigor, and distribution of these important habitat types over large portions of the elk range, it would be most reflective of natural conditions.

Aspen

The presence of wolves would be expected to effectively distribute elk. In addition, the use of fences if necessary to protect aspen on the elk range to prevent elk herbivory would result in increased aspen regeneration, increased stand size and complexity, and increased cover as described under Alternative 2. Through reduced elk population size, increased elk movements, and changed elk grazing patterns, vegetation on the elk range would result in long-term major benefits. The ability to use fire and mechanical vegetation removal actions within aspen stands once aspen have recovered would be a major, long-term benefit. With release of wolves, the recovery of vegetation across the elk range would result in a patchy distribution that would most reflect natural conditions.

Montane Riparian Willow

Lower levels of elk browsing would result in large increases in montane riparian willow production, height, stem density and canopy volume. Montane riparian willow would transform from shorter willow to taller willow and would replace herbaceous vegetation. The increased abundance, competitive ability, and survivorship of willow would result in long-term, major, beneficial impacts, particularly in the core winter range. The ability to use vegetative restoration tools to improve montane riparian willow regeneration would have long-term, major, beneficial effects. These benefits would be offset to some degree due to indirect effects of an increase in the moose population on the primary summer range.

Upland and Riparian Herbaceous Plants

Reductions in the elk population and more effective elk distribution would result in increased upland herbaceous biomass and individual species abundances; however, large-scale effects on

plant species abundance, biodiversity, or composition would not be expected. On the elk range, the long-term beneficial effects would be minor to moderate. The conversion of herbaceous to montane riparian willow shrub as willow coverage increase would represent a minor-to-moderate, adverse effect on herbaceous vegetation, however, this would reflect natural conditions.

Bitterbrush and Sagebrush Upland Shrubs

The effects would be similar to those described in Alternative 2. A reduction in the elk population and more effective distribution would result in increased annual biomass, shrub heights, shrub volume, and canopy, particularly in localized areas of the core winter range where elk densities are excessive. The long-term, beneficial effects on shrub species on the primary winter range would be moderate. Large-scale shifts in species abundance and species diversity would not occur, although increases in individual species abundances would occur, resulting in long-term, minor, beneficial effects on the primary winter range. Wolves would be expected to also reduce the mule deer population and increase mule deer distribution. As a result, the benefits of reduced elk numbers and increased dispersal would not be offset.

Subalpine and Alpine Vegetation

Effects would be the same as described in Alternative 2.

Reductions in the elk population and increased dispersal would reduce elk herbivory in subalpine and alpine riparian and upland willow and herbaceous habitats, resulting in localized increases in native plant species cover and abundance. The reduction in disturbance from elk grazing would result in long-term, major, beneficial effect on riparian and upland willow and minor benefits to herbaceous vegetation.

Exotic Plants

There has been no evidence that elk herbivory in the park results in increased exotic plant species abundance. However, under this alternative, the recovery of native vegetation on the elk range would reduce the potential for spread or invasion of exotic plants. The long-term benefit of a reduction in the potential for exotic plant species infestation would be negligible to minor.

Management Activities

In the reduction phase of the plan, agency lethal reduction operations, herding, carcass disposal, and use of temporary capture facilities would result in localized trampling and loss of individual plants. The short- and long-term effects would be minor, as the areas exposed would be reseeded with native plants. Effects would be reduced to negligible during the maintenance phase of the plan when management operations are less intense, as wolves would reduce the elk population and distribute the population.

The cumulative effects on the elk range from a reduction in elk herbivory and protection of vegetation under this alternative in combination with plans and actions to restore and protect native vegetation would result in overall, moderate-to-major, long-term benefits on aspen, willow, herbaceous, and alpine vegetation. The decrease in elk and deer herbivory on upland shrub habitat as a result of wolves and elk management actions in combination with benefits to upland shrub as a result of burning would have long-term, moderate, beneficial effects on this habitat. In other areas of the park, the release of wolves within the park would have minor benefits to vegetation by distribution of herbivores. This in combination with other management plans to restore vegetation in the park would offset to a large degree actions that result in short-

and long-term, minor, adverse effects and would result in overall minor-to-moderate, beneficial, cumulative effects.

Impairment of vegetation within the park would not occur under Alternative 5.

SPECIAL STATUS SPECIES

Rocky Mountain National Park is responsible for complying with the Endangered Species Act of 1973 and for conserving and protecting animal and plant species that are deemed to have special status by federal and state agencies. The analysis of effects on special status species and critical habitats includes those species listed by the U.S. Fish and Wildlife Service as endangered, threatened, proposed for listing, or considered candidates for listing and with potential to be affected by the elk and vegetation management plan. Designated critical habitats associated with listed species, if any, are also considered in the determination of effects. Species that are considered endangered, threatened or of special concern by the Colorado Division of Wildlife (state-listed species) and have potential to be affected by management actions associated with this plan are also evaluated. The federal- and state-listed species are referred to as "special status species" for this evaluation of effects.

Summary of Regulations and Policies

The *NPS Organic Act* and *Management Policies* (NPS 2006b) provide the basis for resource protection, conservation, and management and are fully described in Chapter 1, "Purpose of and Need for Action."

Director's Order #12 and Handbook: Conservation Planning, Environmental Impact Analysis, and Decision-Making (NPS 2001c) offers guidance to analyze the potential impacts of the alternatives and to prepare the environmental impact statement.

The *Endangered Species Act of 1973* provides strict legal protection for endangered and threatened species, as well as those special concern species that may be in jeopardy of extinction, and for which special protection under federal and state law is afforded. The federal list of plants and animals is published in 50 Code of Federal Regulations 17.11-12 and is administered by the U.S. Fish and Wildlife Service. Special status species of plants and wildlife are included in this section. If the National Park Service determines that an action may adversely affect a federally listed species, consultation with the U.S. Fish and Wildlife Service is required to ensure that the action would not jeopardize the species' continued existence or result in the destruction or adverse modification of designated critical habitat.

The *Bald and Golden Eagle Protection Act of 1940*, as amended, provides for the protection of the bald eagle and the golden eagle (as amended in 1962) by prohibiting the take, possession, sale, purchase, barter, transport, export or import, or offer to sell, purchase or barter of any bald or golden eagle, alive or dead, including any part, nest, or egg, unless allowed by permit. "Take" includes pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest, or disturb.

Methodologies and Assumptions for Analyzing Impacts

Geographic Area Evaluated for Impacts

The geographic boundaries for the analysis include the primary winter and summer ranges of the Rocky Mountain / Estes Valley elk population (see Figure 1.1), Rocky Mountain National Park, and areas beyond the park where the plan's management actions have the potential to affect listed species or their habitats. Actions in the park must be analyzed to determine if those actions would impact wide-ranging species or species that are found outside the park in addition to species known to use habitats in the park.

Issues

Issues that were identified during internal and public scoping regarding elk and vegetation management activity effects on listed species include the following:

The potential for management actions in the park to produce downstream effects on special status species.

Effects of elk population or vegetation alteration on special status species' breeding or foraging habitats.

Changes in wildlife species composition affecting a special status species' prey base.

Direct physical impacts on special status species' habitat (e.g., trampling or soil disturbance).

Effects of lethal elk population reduction activities (especially firing weapons) or redistribution actions on special status species.

Assumptions

The following assumptions were used to perform the analysis of elk and vegetation management actions on special status species in addition to the more general assumptions associated with all impact topics that were presented earlier:

Fencing would not restrict the movement of special status species or their access to resources or habitat.

Wolves (either a released or naturally dispersing population) would prey primarily on elk.

The gray wolf would retain its current listing as a federally listed endangered species, although the wolves released in the park would likely be classified as a non-essential experimental population. Wolves that naturally disperse to the park would have endangered status.

Listed Species to Be Evaluated

The listed species that were retained for a full evaluation of the effects of the elk and vegetation management plan are presented in Table 3.2, in Chapter 3, "Affected Environment." The rationale for retaining these species and their descriptions is also presented in that section. None of the species retained for evaluation has designated critical habitat in the park or within the elk primary winter or summer ranges. As a result, none of the alternatives would have any effect on any critical habitat.

Assessment Methods

Impacts on special status species include any activity that may be considered a "taking" or that may cause harm to a species as defined under the Endangered Species Act, including harassment and degradation or loss of habitat. Potential effects on a listed species are treated very conservatively to provide maximum protection. Long-range effects of seemingly beneficial actions must be evaluated for potential impacts on listed species.

Potential impacts on special status species or their habitat were evaluated based on the known presence of a species or its potential presence due to suitable available habitat. The methods used to evaluate the impacts on special status species used Alternative 1 as the baseline condition against which the action alternatives were compared because Alternative 1 represents current

management conditions. The analysis focuses on the effects on special status species with respect to the implementation of the management actions described in Alternatives 2, 3, 5, and 5. To understand the effects of elk and vegetation management methods on listed species, park resource inventories and management plans, scientific literature, and published technical data were consulted to analyze different resource management approaches.

Impact Threshold Definitions

Intensity of Impact

Impact intensity level thresholds were defined to facilitate the determination of effects as follows:

Negligible: No special status species would be affected, or the action would affect an individual of a listed species or its critical habitat, but the change would be so small that it would not be of any measurable or perceptible consequence to the protected individual or its population; a discountable effect.

Minor: The action would result in detectable impacts on an individual (or individuals) of a listed species or its critical habitat, but the action would not be expected to result in substantial population fluctuations and would not be expected to have any measurable effects on species, habitats, or natural processes sustaining them.

Moderate: An action would result in detectable impacts on individuals or a population of a listed species, its critical habitat, or the natural processes sustaining them. Key ecosystem processes may experience disruptions that may result in population or habitat condition fluctuations that would be outside the range of natural variation but would return to natural conditions.

Major: Individuals or a population of a listed species, its critical habitat, or the natural processes sustaining them would be measurably affected, including mortality for special status individuals. Key ecosystem processes might be permanently altered, resulting in changes in population numbers or permanently modifying critical habitat.

Type and Duration of Impact

Beneficial effects are likely to protect or restore the abundance and distribution of a listed species. This could occur through increased survival, reproduction, or availability of habitat or required resources.

Adverse effects are likely to result in undesirable changes in the abundance or distribution of a listed species. This could occur through direct disturbance, mortality, decreased reproduction, or through destruction or alteration of habitat.

Duration: Short-term effects would last less than one year. Long-term effects would persist for one year or more.

Impairment

An impairment of a listed species would occur when the action contributes substantially to deterioration of the listed species or its critical habitat in the park to the extent that the listed species would no longer survive as a viable population. Impairment would "jeopardize the continued existence" of a listed species in that the action would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species [50

Code of Federal Regulations 402.02]. In addition, the adverse effects on listed species in the parks and their critical habitat

Alternative 1

This alternative would continue the existing management framework for special status species. These management activities include habitat improvements in the Kawuneeche Valley for the Colorado River cutthroat trout and in east slope-waters for the green-backed cutthroat trout, as well as maintenance of the reintroduced river otter population in the Colorado River drainage.

Boreal Toad

Continued degradation of montane riparian and wetland habitat by high numbers and concentrations of elk on the elk range would represent a long-term, local, moderate adverse effect on the boreal toad. In addition, elk concentrations in riparian meadows and wetland areas would continue to potentially trample the toad or its habitat. Trampling can kill toads or destroy egg masses, causing a long-term, local, moderate adverse effect on the boreal toad population.

Wood Frog

If montane riparian willow habitat degradation as a result of elk herbivory were to occur in the Kawuneeche Valley, wood frog habitat would be adversely affected. Degradation of willows is not well-documented on the west slope of the park, but there is the potential that as elk become more habituated to browsing in one place, as they do in eastern portions of the park, willows could become degraded in a similar fashion to those on the east side of the park. Effects on wood frog habitat from elk herbivory would likely be limited, though, due to decreased densities of elk on the primary summer range. Effects would be long term, local, minor, and adverse. Trampling by elk could also kill frogs or destroy egg masses but, again, would likely occur on a limited basis, resulting in long-term, local, negligible, adverse effects.

Greenback Cutthroat Trout

Degraded montane riparian vegetation conditions, specifically lack of willow overstory along stream banks, could cause an adverse effect on greenback trout and its habitat because lack of cover could warm water temperature and would not provide hiding cover for fish. The effect on greenback cutthroat trout as a result of habitat degradation would be long-term, local, negligible, and adverse. The characterization of the effect intensity is a result of the spatial separation between most of the streams inhabited by greenback cutthroat trout (NPS 2005b) and the core winter elk range, where montane riparian willow habitat has been adversely affected to the greatest degree. Most greenback cutthroat trout habitat in the park is upstream of the areas where elk foraging has adversely affected willow cover along streams. Hidden Valley Creek is within the elk range, and there is a remnant population of greenback cutthroat trout. In addition, this area has been identified as a restoration area to supplement the greenback cutthroat trout population. The potential for the continuation and spread of habitat degradation is the basis for the negligible, adverse effect finding.

Colorado River Cutthroat Trout

Effects on the Colorado River cutthroat trout would likely be similar to those described for greenback trout, although of negligible-to-minor intensity. Degradation of montane riparian

habitat as a result of elk foraging behavior is not well documented in the Colorado River drainage (west slope of the park), although it is suspected. This elk population does not winter on the west slope, so the potential effects are substantially less than in the core winter range. Nonetheless, these effects could occur over the long-term, and identifying potential management actions that could forestall degradation would support resource management goals in the park.

Greater Sandhill Crane

Similar to the Colorado River cutthroat trout, the greater sandhill crane uses habitat in the Kawuneeche Valley on the west slope of the park. If montane riparian willow habitat degradation as a result of elk herbivory were to occur, nesting habitat in Kawuneeche Valley could be adversely affected. This effect would be long term, local, and negligible because only one pair of sandhill cranes are currently known to nest in the park and the amount and quality of montane riparian willow habitat (preferred nesting habitat for the crane) would be more than sufficient to support nesting cranes in the park.

Long-billed Curlew

Current management actions associated with elk and vegetation in the park would not have an effect on the curlew because it is considered a very rare migrant through the park (only one record of occurrence) and its preferred habitat is short-grass grassland (Andrew and Righter 1992). Continuing current NPS actions would not affect the long-billed curlew's breeding habitat at lower elevations in Larimer County.

Bald Eagle

Although bald eagles do forage on elk carcasses, continuing current management of elk and vegetation would have little effect on the bald eagle because the eagles that winter in the park, as well as the pair that forages in the park in summer, use habitat that is mostly outside the elk range of interest. Bald eagles primarily use habitats on the west side of the park between Shadow Mountain Dam and Columbine Bay on Lake Granby, which is not within the elk range being evaluated. If eagles do use habitats inside the elk range, Alternative 1 would not affect the availability of elk carcasses, with the exception of the removal of carcasses that test positive for chronic wasting disease. The potential adverse effect on the bald eagle would be long-term, local, and negligible.

River Otter

Effects on the river otter would potentially occur in the Colorado River drainage on the west slope of the Continental Divide in the Kawuneeche Valley basin. As described for the wood frog, Colorado River cutthroat trout, and the greater sandhill crane, there is little documentation regarding montane riparian habitat degradation on the west side of the park, although there are good reasons to suspect that elk foraging may be adversely affecting that habitat. Continuing current management would have a long-term, negligible to minor, local, adverse effect on the river otter because of the potential for degraded montane riparian conditions and adverse effects on fish populations, which could in turn affect the otter.

Wolverine

Although there is potential wolverine habitat in the park, intensive survey efforts (Seidel et al. 1998) have not confirmed the presence of wolverines in the park. Ten sets of wolverine tracks were found near the park, but none were confirmed in Rocky Mountain National Park (Seidel et al. 1998). Wolverines feed on carrion and would likely feed on elk carcasses. If the wolverine were present in the backcountry areas of the park, it is possible they would rely on elk carcasses for food. The removal of elk carcasses that test positive for chronic wasting disease would have a discountable and inconsequential effect on the wolverine. As a result, Alternative 1 would not affect the wolverine.

Canada Lynx

Current management actions related to elk and vegetation management in the park would not have any consequences, with the exception of the removal of elk carcasses that test positive for chronic wasting disease. Although lynx feed primarily on snowshoe hare, with a small percentage of voles, mice, squirrels, and birds in their diet when hares are scarce and in summer and fall, they will occasionally scavenge carrion (Koehler and Aubry 1994). As a result, the removal of elk carcasses that test positive for chronic wasting disease would have a negligible, adverse effect on Canada lynx. Although degraded montane riparian habitat conditions on the core winter elk range could affect lynx use of this habitat in summer, these areas are relatively close to development and are frequented by humans, thus minimizing the likelihood of use by lynx. Lynx do prey on snowshoe hare in riparian willow habitat, so this would offset, to some degree, their reluctance to approach developed areas. Alternative 1 would have long-term, local, negligible-to-minor, adverse effects on the Canada lynx.

Cumulative Impacts

In recent years, the use of low-flying commercial air tours over the park and the use of snowmobiles on Trail Ridge Road have been banned, a long-term, regional, negligible, beneficial effect on special status species. Wildlife vary in their responses to noise, but it can negatively affect many species through changes in behavior and physiological effects (USAF and USFWS 1988).

A number of actions in the park and on adjacent lands involve improving forest health, through controlling the pine bark beetle and managing forest fuels through mechanical thinning and prescribed fire. These activities would adversely affect special status species through temporary displacement and short-term alteration of habitat, a short-term, minor, adverse effect. However, these actions would result in long-term, minor, beneficial effects on special status species, particularly lynx, through improved habitat.

Management plans for protecting the park's natural resources would benefit special status species through maintaining and restoring natural conditions and limiting intrusive activities. Effects would be long term, minor-to-moderate, and beneficial. Restoring vegetative communities and removing exotic plants in the park would also enhance habitat, a long-term, minor, beneficial effect on special status species.

Restoration plans focused on special status species (greenback cutthroat trout, Colorado River cutthroat trout, boreal toad, and, potentially, lynx and wolverine) in the park, as well as conservation lands occurring outside the park, would enhance and conserve aquatic and terrestrial habitats in the long term, a moderate benefit to special status species.

Activities outside the park also affect special status species within the park, as individuals outside can be within the same population as those within the park. Development in the Estes Valley, on the west side of the park near Grand Lake, and in other areas outside of the park would continue to fragment and reduce habitat that could be used by special status species. On a regional scale, depending on the specific species, this would represent a long-term, moderate to major, adverse effect on special status species.

Effects from other plans, projects, and actions would vary according to the special status species, its habitat requirements, and the locations of the activities. The effects could range from short term, minor, and adverse to long term, moderate, and beneficial. Overall, Alternative 1 would have a long-term, negligible-to-moderate contribution to adverse cumulative effects on special status species. The overall cumulative effects of other plans, projects, and actions, combined with the effects of Alternative 1, would be short- and long-term, minor, and adverse.

Conclusion

Alternative 1 would have no effect on the long-billed curlew or wolverine. Changes in habitat would lead to negligible, adverse effects on the greenback cutthroat trout, greater sandhill crane, river otter, and bald eagle; negligible-to-minor, adverse effects on the Colorado River cutthroat trout and Canada lynx; and minor, adverse effects on the wood frog. The boreal toad could experience moderate, adverse effects as a result of continued degradation of montane riparian and wetland habitat on the elk range and the direct adverse effects of trampling by high concentrations of elk in boreal toad habitat.

The overall cumulative effects of other plans, projects, and actions combined with the effects of Alternative 1 would be short term and long term, minor, and adverse.

Using the impairment analyses methods described earlier, there would be no impairment of special status species' values or resources as a result of the implementation of Alternative 1.

Alternative 2

All Special Status Species

The lethal elk reduction activities; use of redistribution techniques to disperse high concentrations of elk; and research activities conducted in concert with elk management activities in the first three years of the plan could potentially disturb special status species in the vicinity of the actions. Lethal reduction actions using suppressed-noise weapons would mitigate this potential disturbance to a degree; the actions of the reduction team would still have some effect as carcasses were removed and teams moved through habitat. The actions taken would avoid sensitive periods of species' life cycles and sensitive locations, such as known breeding or nesting sites and seasons (see "Affected Environment" for special status species), to minimize the potential for disturbance during these sensitive periods. The potential for disturbance would be directly related to the likelihood that a special status species would use habitat where elk tend to congregate in high densities, such as meadows and montane riparian areas on the elk range and preferred foraging areas. The reduction, research, and redistribution activities would occur for relatively short periods, and some special status species could easily avoid the affected areas. The potential adverse effect of these activities with mitigations would be short term, local, and negligible.

Many of the special status species rely to one degree or another on montane riparian, wetland, or aquatic habitats. The restoration or reintroduction of beaver populations would support more of

these habitats and, in turn, provide benefits for the special status species that use the habitats. This effect would be long term, minor-to-moderate, beneficial, and would extend from local areas to areas throughout the winter and summer elk ranges. The reintroduction of beaver would not cause downstream effects outside the elk range that would require analyses because the actions would be contributing to a restoration of former conditions.

Boreal Toad

Fewer elk and lower elk densities in combination with improved conditions in montane riparian habitat would benefit the boreal toad. The reduced potential for trampling of toads or toad egg masses as a result of greater structural complexity in a restored willow community would contribute to this beneficial effect. The restoration of montane riparian willow communities, beaver populations, and the aquatic habitats created and maintained by beaver would be especially beneficial for boreal toad habitat. This would represent a long-term, local, moderate benefit for the boreal toad.

Wood Frog

Improved conditions in montane riparian areas in the Kawuneeche Valley and reduced potential for trampling from decreased numbers and densities of elk and thicker, taller willow habitats would benefit the wood frog. This would represent a long-term, local, minor benefit for the wood frog.

Greenback Cutthroat Trout

Improvements in montane riparian habitat conditions would benefit the greenback cutthroat trout. The potential return of beaver and resulting enhancement of aquatic habitats would contribute to this benefit. As noted in the discussion of greenback cutthroat trout under Alternative 1, there is only a small overlap between existing and future greenback cutthroat trout habitat and the montane riparian willow habitats that are most likely to experience improvements. As a result, the long-term, local benefits for the greenback cutthroat trout would be negligible.

Colorado River Cutthroat Trout

The beneficial effects of Alternative 2 on the Colorado River cutthroat trout would be similar to those described for greenback cutthroat trout, although the long-term, local benefit would increase to moderate. The reason for the greater potential benefit is because summer elk range in the Kawuneeche Valley overlaps with streams and rivers used by Colorado River cutthroat trout to a greater degree than the intersection of core winter elk range and greenback cutthroat trout habitat on the eastern side of the park.

Greater Sandhill Crane

Enhanced montane riparian habitat along the Colorado River and tributaries in the Kawuneeche Valley as a result of management actions associated with Alternative 2 would benefit the greater sandhill crane. Restoration or reintroduction of the beaver population and the aquatic habitats created and maintained by beaver would be especially beneficial. The park is on the periphery of the crane's breeding range, and migratory use of park habitats is limited (Andrew and Righter 1992). As a result, benefits to the greater sandhill crane would be long term, local, and negligible.

Long-billed Curlew

Although the likelihood of the long-billed curlew being affected by management actions associated with any of the action alternatives is very low, nevertheless, there is potential for migrating curlews to make use of habitat in the park. As a result, enhanced montane riparian habitat would present a long-term, local, negligible benefit to the long-billed curlew as additional structural cover would be present and could provide protection for the bird during migratory stops.

Bald Eagle

The number of elk carcasses that would be left in the environment during the first four years of the plan, when lethal elk reduction activities would be maximized, may be greater than under other alternatives. This would provide additional foraging opportunities for the bald eagle in those parts of the park where eagles forage and are found in the same areas where elk reductions would be implemented. The overlap between areas that eagles are known to use and where elk reduction activities would occur is small. Although the number of carcasses would decline in years five through 20, the overall benefit to eagles would remain negligible.

River Otter

Enhanced montane riparian habitat in the Kawuneeche Valley could provide additional terrestrial cover along stream and riverbanks for the river otter. Increased beaver populations and more beaver ponds would add to the benefits for the otter as a result of increased quality and quantity of preferred otter habitat. As described for the Colorado River cutthroat trout, montane riparian habitat restoration would potentially benefit fish populations, which in turn would increase the prey base for the river otter. Together, the improvements in habitat and prey base would represent a long-term, local, minor benefit for the river otter.

Wolverine

As described for the bald eagle, the number of elk carcasses left in the environment may increase during the first four years of Alternative 2. The potential benefit for the wolverine would be small because of the uncertainty associated with the potential for wolverine to even exist in the park. Nonetheless, the increase in a potential food source would represent a long-term, local, negligible benefit for any wolverine that would use the park. Although the number of carcasses would decline in years five through 20, the overall benefit to wolverines would remain negligible.

Canada Lynx

Increases in structural complexity and the areal extent of montane riparian habitat associated with restoration of montane riparian willow communities would benefit Canada lynx that frequent montane riparian habitat in summer. The benefit would primarily be associated with increased foraging conditions and opportunities. In addition, because lynx may consume carrion if other prey is limited or unavailable, the potential for an increase in elk carcasses left in the environment during the first four years of the plan would contribute to beneficial effects for the lynx. Overall, the beneficial effects on the lynx as a result of Alternative 2 would be long term, local, and minor. The intensity is minor because of the relatively little time that lynx would be expected to occur in the habitats of the core winter elk range.

Cumulative Impacts

Effects of other plans, projects, and actions on special status species would be the same as described for Alternative 1: long term, minor, adverse and short term, minor, and adverse. Alternative 2's contribution to cumulative effects would be long term, moderate, and beneficial as well as short term, negligible, and adverse. When the effects of other plans, projects, and actions are combined with those of Alternative 2, the cumulative effects would be long term, negligible to minor, and beneficial as well as short term, minor, and adverse.

Conclusion

Alternative 2 would be beneficial for special status species except for disturbance effects associated with lethal elk reduction and research activities and redistribution actions to disperse high concentrations of elk. The adverse effects of elk management and research activities would be temporary and negligible. The benefits that would accrue would be negligible for greenback cutthroat trout, greater sandhill crane, long-billed curlew, bald eagle, and wolverine (decreasing to no effect in the fifth through 20th years for bald eagle and wolverine); minor for river otter, Canada lynx, and wood frog; minor-to-moderate for special status species that rely on montane riparian, wetland, and aquatic habitats as a result of beaver restoration or reintroduction; and moderate for boreal toad and Colorado River cutthroat trout.

When the effects of other plans, projects, and actions are combined with those of Alternative 2, the cumulative effects would be long term, negligible to minor, and beneficial as well as short term, minor, and adverse.

Using the impairment analyses methods described earlier, there would be no impairment of special status species' values or resources as a result of the implementation of Alternative 2.

Alternative 3

All Special Status Species

The lethal elk reduction activities, use of redistribution techniques to disperse high concentrations of elk, installation of fences, and research activities could potentially disturb terrestrial special status species in the vicinity of the actions. Lethal reduction actions using suppressed-noise weapons would mitigate this potential disturbance to a degree; the actions of the reduction team would still have some effect as carcasses were removed and teams moved through habitat. The actions taken would avoid sensitive periods of species' life cycles and sensitive locations, such as known breeding or nesting sites and seasons, to minimize the potential for disturbance during these sensitive periods. The potential for disturbance would be directly related to the likelihood that a species would use habitat where elk tend to congregate in high densities, such as meadows and montane riparian areas on the core winter range and preferred foraging areas. Lethal elk reduction actions would be less intense than under Alternative 2, and the potential short-term, local, adverse effects would be negligible but incrementally less than with Alternative 2. Redistribution activities would occur more frequently than in Alternative 2, although the effect would be similar to but incrementally greater than the description of effects for Alternative 2.

The effects of beaver population restoration or reintroduction would have effects on special status species similar to those described for Alternative 2. Installation of fences would have local, short-term, adverse, negligible effects.

Boreal Toad

The effects of Alternative 3 on the boreal toad would be similar to those described for Alternative 2. Fencing of montane riparian willow habitat would protect much boreal toad habitat from the effects of high concentrations of elk; however, the target elk population would be higher than for Alternative 2. The net effect would be long-term, local, beneficial, and moderate.

Wood Frog

The effects of Alternative 3 on the wood frog would be similar to those described for Alternative 2. Although the total elk population would be higher under Alternative 3, 180 acres of willow habitat would be fenced in the Kawuneeche Valley, providing habitat for the frog that is free of disturbance by elk. Areas outside fences would be browsed at a higher level, reducing habitat quality, and frogs would continue to be at risk from trampling by elk and from redistribution efforts, reducing some of the beneficial effects of fences. Overall, this alternative would result in a long-term, local, minor benefit for the wood frog.

Greenback Cutthroat Trout

Assuming that montane riparian willow habitat in Hidden Valley Creek and other greenback cutthroat trout habitat in the core winter elk range would be fenced, the restoration of montane riparian vegetation and subsequent benefits to aquatic habitats would be similar to but incrementally greater than those described for Alternative 2 (i.e., minor benefits). If montane riparian willow habitat along streams containing greenback cutthroat trout in the core winter elk range were not fenced, the effects on the trout would be long term, local, negligible, and beneficial because the habitat improvements would not be as great, nor occur as quickly, as described for Alternative 2.

Colorado River Cutthroat Trout

Effects on the Colorado River cutthroat trout would occur as a result of habitat restoration similar to the reasons described for Alternative 2 and at a similar intensity. Protection of montane riparian habitat with fences in the Kawuneeche Valley would provide increased cover and shading along streams and rivers and provide habitat for beaver, resulting in further enhancement of aquatic habitats. In fenced areas, the benefit would be long-term and moderate. In montane riparian areas that were not fenced, the effects on trout would be long term, local, minor, and beneficial because the habitat improvements would not be as great nor occur as quickly as described for Alternative 2.

Greater Sandhill Crane

The restoration of vegetation would be to the same degree as described under Alternative 2 with the use of fences and increased redistribution actions to protect montane riparian willow in the Kawuneeche Valley. However, as the park is in the periphery of the crane's breeding range, the beneficial effects would be negligible.

Long-billed Curlew

The effects of Alternative 3 would be similar to (i.e., negligible benefits) but incrementally less than those described for Alternative 2 because the actions to restore habitat that the long-billed curlew may use under Alternative 3 would not achieve results as quickly nor to as great a degree.

Bald Eagle

The effects of Alternative 3 on the bald eagle would be related to the availability of carrion, as described for Alternative 2. Because Alternative 3 would employ a moderate, constant rate of lethal elk reduction throughout the 20-year life of the plan, it is not expected that carcasses would be left in the environment exceeding natural conditions. The effect on the bald eagle with respect to carrion availability would be long-term and negligible.

River Otter

Effects on the river otter would occur as a result of habitat restoration and benefits to fish populations similar to that described for Alternative 2. Enhancement of montane riparian habitat with fences in the Kawuneeche Valley would provide increased cover along streams and rivers. An increase in beaver populations that may result from restored vegetation would add increased quality habitat for otters. The improvements in habitat and prey base would represent a long-term, local, minor benefit for the river otter.

Wolverine

As described for the bald eagle, potential effects on the wolverine would be related to the availability of carrion, as described for Alternative 2. Because Alternative 3 would employ a moderate, constant rate of lethal elk reduction throughout the 20-year life of the plan, it is not expected that carcasses would be left in the environment exceeding natural conditions; thus there would be a long-term, negligible effect on the wolverine. Fencing would not be expected to affect the wolverine.

Canada Lynx

The effects of Alternative 3 on the Canada lynx would be similar to and occur for the same reasons as those described for Alternative 2. The difference between the alternatives would be related to the speed and magnitude of montane riparian habitat restoration. Under Alternative 3, vegetation restoration would be more a function of fenced protection from herbivory than elk population reduction. Because fencing would likely be used in greater proximity to humans and development (i.e., the core winter elk range) than the overall areas that would be affected by elk population reductions, and lynx would likely occur less often in proximity to development, the long-term, local, minor benefit to the lynx under Alternative 3 would be similar to but incrementally less than Alternative 2's effect.

Cumulative Impacts

Cumulative effects would be the same as described for Alternative 2.

Conclusion

Alternative 3 would benefit special status species except for disturbance effects associated with lethal elk reduction activities, redistribution actions to disperse high concentrations of elk, fence installation activities, and research study activities. Reduction actions would have a temporary, negligible, adverse effect on special status species, incrementally less than those under Alternative 2. Redistribution activities would also have a temporary, negligible effect incrementally greater than Alternative 2 because redistribution would be used more often. Alternative 3 would have negligible effect on the bald eagle or wolverine. The benefits that

would accrue would be negligible for greenback cutthroat trout (in areas where montane riparian willow habitat would not be fenced), long-billed curlew, and greater sandhill crane; minor for greenback cutthroat trout and wood frogs (where habitat would be fenced), and Canada lynx; minor to moderate for Colorado River cutthroat trout in unfenced and fenced areas, respectively; minor to moderate for special status species that rely on montane riparian, wetland, and aquatic habitats as a result of beaver restoration or reintroduction; and moderate for the boreal toad.

When the effects of other plans, projects, and actions are combined with those of Alternative 3, the cumulative effects would be long term, negligible to minor, and beneficial as well as short term, minor, and adverse.

Using the impairment analyses methods described earlier, there would be no impairment of special status species' values or resources as a result of the implementation of Alternative 3.

Alternative 4

All Special Status Species

Lethal elk reduction, fencing aspen and willow communities on the primary winter range, actions taken to redistribute elk; and research activities would have effects on special status species similar to those described for Alternative 3. Because fences would not be erected to protect montane riparian willow on the primary summer range, the effects on special status species that occur in this portion of the elk range would differ from Alternative 3 as described below. Mitigation measures, such as avoiding sensitive breeding locations and times, would be implemented to minimize the potential to affect special status species.

If the fertility control agent for elk population management can be administered remotely (i.e., using darting methods without capturing and sedating elk), the effects on special status species would be associated with the potential presence of treatment teams in habitats used by special status species and the temporary disturbance the teams would create. This would represent a short-term, local, negligible, adverse effect on special status species if special status species were in the vicinity or, more likely, no effect if no special status species were in the vicinity of treatment actions. If an elk capture facility would be required for elk population management, the potential disturbance-related effects would last longer and likely be distributed over a larger area, leading to a short-term, local, negligible-to-minor, adverse effect on special status species that might be in the vicinity. As described in the "Wildlife" impact topic section, the need to capture elk could be met using a capture facility such as a corral trap. The potential impacts of these activities on special status species would be short term and local, but the adverse effect would be minor depending on the specific location, the method used, the habitat that would be affected, and the potential for being in the vicinity of habitat that might be occupied by special status species.

The fertility control agents used for population management or research purposes would have no effect on any special status species. One of the criteria for the control agent states, "A fertility control agent must not have any adverse effects on non-target animals that consume elk meat. These would include no toxicity, no change in fertility, and no genetic mutations that would interfere with life cycles or be passed on to subsequent generations." In the case of Leuprolide, the active hormone would not pass into the food chain because it would cleave to constituent amino acids (Becker and Katz 1993). Any other fertility control agent considered for use would be required to meet the "no effect on non-target species" criterion as well. As a result, there would be no food chain effects on special status species from the administration of fertility control agents to elk. The transport to waterways of the potential agents described in Chapter 2 is unknown at this time. If, based on monitoring or new scientific information, it is determined that

fertility control agents are found to have affects on nontarget species, including fish, the use of the agent would be modified or stopped. Every effort would be made by staff to retrieve darts that have missed their target.

Boreal Toad

The effects of Alternative 4 on the boreal toad would be similar to those described for Alternative 3.

Wood Frog

The effects of Alternative 4 on the wood frog would be similar to those described for Alternative 2, although incrementally less because the total elk population, and therefore elk herbivory, would be somewhat higher.

Greenback Cutthroat Trout

The effects of Alternative 4 on the greenback cutthroat would be similar to those described for Alternative 3.

Colorado River Cutthroat Trout

Effects on the Colorado River cutthroat trout would occur as a result of habitat restoration similar to the reasons described for Alternative 3 and at a similar intensity. However, because there would be no fencing of montane riparian willow habitat in the Kawuneeche Valley under Alternative 4 and the lethal elk reduction targets would result in elk populations higher than in Alternative 2, benefits for the Colorado River cutthroat trout would be minor rather than moderate because of slower restoration of montane riparian vegetation and a higher elk population.

Greater Sandhill Crane

The restoration of vegetation would be slower than under Alternative 2 because the elk population target is higher. No fencing to protect montane riparian willow vegetation would be installed in the Kawuneeche Valley. Thus, the effects on the greater sandhill crane would occur for the same reasons described for Alternative 2 but would accrue as a negligible benefit.

Long-billed Curlew

The effects of Alternative 4 would be similar to (i.e., negligible benefits) but incrementally less than those described for Alternative 2 because the actions to restore habitat that the long-billed curlew may use under Alternative 4 would not achieve results as quickly nor to as great a degree.

Bald Eagle

The effects of Alternative 4 on the bald eagle would be related to the availability of carrion, as described for Alternative 3. The effect with respect to carrion availability would be long term and negligible.

River Otter

The enhancement of montane riparian habitat in the Kawuneeche Valley would not be as great as described for Alternative 2 because the elk population target would be higher. No montane riparian willow habitat would be fenced on the west side of the park and as a result, vegetation restoration in montane riparian willow habitat would proceed relatively slowly in the Colorado River basin. The long-term, local, beneficial effects on the river otter as a result of Alternative 4 would be negligible.

Wolverine

As described for the bald eagle, potential effects on the wolverine would be related to the availability of carrion, as described for Alternative 3. There would be a long-term, negligible effect on the wolverine.

Canada Lynx

The effects of Alternative 4 on the Canada lynx would be similar to and occur for the same reasons as those described for Alternative 2. The difference between the alternatives would be related to the speed and magnitude of montane riparian habitat restoration. Under Alternative 4, vegetation restoration would be more a function of fenced protection from herbivory than elk population reduction. Because fencing would likely be used in greater proximity to humans and development (i.e., the core winter elk range) than the overall areas that would be affected by elk population reductions, and lynx would likely occur less often in proximity to development, the long-term, local, minor benefit to the lynx under Alternative 4 would be similar to but incrementally less than Alternative 2's effect.

Cumulative Impacts

Cumulative effects would be the same as described for Alternative 3.

Conclusion

Alternative 4 would benefit special status species except for disturbance effects associated with lethal elk reduction activities, redistribution actions to disperse high concentrations of elk, fence installation activities, and research activities. Reduction actions would have a temporary, negligible, adverse effect on special status species, incrementally less than those under Alternative 2. Redistribution activities would also have a temporary, negligible effect incrementally greater than Alternative 2 because redistribution would be used more often.

Administering fertility control agents remotely would have negligible, short-term, adverse effects on special status species in the vicinity of activities. Use of a capture facility for elk population management would have greater adverse effects up to minor in intensity due the area disturbed and length of disturbance.

Alternative 4 would have negligible effects on the greater sandhill crane, bald eagle, and wolverine. The benefits that would accrue would be negligible for greenback cutthroat trout (in areas where montane riparian willow habitat would not be fenced), long-billed curlew, and river otter; minor for greenback cutthroat trout (where habitat would be fenced), Colorado River cutthroat trout, wood frog, and Canada lynx; minor to moderate for special status species that rely on montane riparian, wetland, and aquatic habitats as a result of beaver restoration or reintroduction; and moderate for the boreal toad.

When the effects of other plans, projects, and actions are combined with those of Alternative 4, the cumulative effects would be long term, negligible to minor, and beneficial as well as short term, minor, and adverse.

Using the impairment analyses methods described earlier, there would be no impairment of special status species' values or resources as a result of the implementation of Alternative 4.

Alternative 5

All Special Status Species

The effects of Alternative 5 on special status species would be similar to those described for Alternative 2. However, because benefits would primarily occur as a result of the improvement in montane riparian willow and aspen habitat quality and quantity, the benefits would mostly accrue for the greenback cutthroat trout, Colorado River cutthroat trout, boreal toad, wood toad, greater sandhill crane, lynx, and river otter. The primary mechanism supporting the habitat restoration would be the constant risk of predation posed to elk by wolves and the resulting trophic cascade that would benefit vegetative communities (Ripple et al. 2001, Ripple and Beschta 2004b, Hebblewhite et al. 2005). Because of the relatively small wolf population that would be present in the early stages of this alternative, lethal reduction of elk would augment wolf disturbance and predation to achieve the reductions in the elk population and the subsequent drop in herbivory levels.

There would be small differences from Alternative 2 in the benefits for special status species that rely on carrion for food. Because wolves would prey on elk throughout the year, more carcasses would be available in all seasons, rather than peaking in the late fall and winter when the majority of the lethal control actions would be implemented. This would provide an incrementally greater benefit than the local, negligible benefit described under Alternative 2 for special status species that scavenge carrion.

Another difference from the effects of Alternative 2 would be the potential for competition between wolves and Canada lynx and wolverine. Although there is potential for these carnivores to compete for prey, the small number of wolves would make the potential adverse effects of competition for resources for the lynx and wolverine negligible. Furthermore, temporal and spatial avoidance or differences in hunting and foraging strategies would likely minimize the effects of competition between the wolf, wolverine, and lynx (Carroll et al. 1999, Turbak 2005). In Rocky Mountain National Park, wolves preying on elk would provide a food source for wolverines after feeding on the carcass, while the lynx would likely prey on the snowshoe hare.

Cumulative Impacts

Cumulative effects would be the same as described for Alternative 2.

Conclusion

The effects of Alternative 5 on special status species would be similar to those described under Alternative 2. Disturbance effects associated with lethal elk reduction and research activities would be short-term and negligible. Beneficial effects associated with montane riparian willow and aspen habitat recovery would be long-term, park-wide, and negligible. Slight differences might occur for special status species that feed on carrion as a result of wolves providing

carcasses throughout the year, compared to the spike in carcass availability that would occur under Alternative 2 when lethal control efforts would peak in late fall and winter.

When the effects of other plans, projects, and actions are combined with those of Alternative 5, the cumulative effects would be long term, negligible to minor, and beneficial as well as short term, minor, and adverse.

Using the impairment analyses methods described earlier, there would be no impairment of special status species values or resources as a result of the implementation of Alternative 5.

OTHER WILDLIFE SPECIES

Rocky Mountain National Park is responsible for protecting wildlife (including fish, invertebrates, and all native wild animal species) as a park resource. The wildlife section does not include elk because the elk population, as the primary resource addressed by this management plan, was addressed as an independent impact topic. Wetlands and montane riparian communities are important wildlife habitats. This section addresses general changes to wildlife habitat, while specific effects on wetland vegetation and water quality in the park are addressed in each of those topics' respective sections.

Summary of Regulations and Policies

The *NPS Organic Act* and *Management Policies* (NPS 2006b) provide the basis for resource protection, conservation, and management and are fully described in Chapter 1, Purpose and Need.

Director's Order #12 and Handbook: Conservation Planning, Environmental Impact Analysis and Decision-Making (NPS 2001c) offers the guidance to analyze the potential impacts of the alternatives and to prepare the environmental impact statement.

The *Fish and Wildlife Coordination Act of 1934*, as amended, requires consultation with the U.S. Fish and Wildlife Service and the fish and wildlife agencies of states to prevent "loss of and damage to wildlife resources." A key point of this act is that it pertains to water resource modification projects as described by the following:

> The Act provides that whenever the waters or channel of a body of water are modified by a department or agency of the U.S., the department or agency first shall consult with the U.S. Fish and Wildlife Service and with the head of the agency exercising administration over the wildlife resources of the state where construction will occur, with a view to the conservation of wildlife resources.

The *Migratory Bird Treaty Act of 1918*, as amended, prohibits the taking, killing, possession, transportation, and importation of migratory birds, their eggs, parts, and nests except as authorized under a valid permit (50 CFR 21.11). Additionally, the act authorizes and directs the Secretary of the Interior to determine if, and by what means, the take of migratory birds should be allowed and to adopt suitable regulations permitting and governing take (for example, hunting seasons for ducks and geese). "Take" includes pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest, or disturb.

The *Bald and Golden Eagle Protection Act of 1940*, as amended, provides for the protection of the bald eagle and the golden eagle (as amended in 1962) by prohibiting the take, possession, sale, purchase, barter, offer to sell, purchase or barter, transport, export or import, of any bald or golden eagle, alive or dead, including any part, nest, or egg, unless allowed by permit. "Take" includes pursue, shoot, shoot at, poison, wound, kill, capture, trap, collect, molest, or disturb.

Methodologies and Assumptions for Analyzing Impacts

Geographic Area Evaluated for Impacts

The geographic area evaluated for impacts on wildlife includes the primary winter and summer ranges of the Rocky Mountain National Park / Estes Valley elk population (see Figure 1.1 in the

"Scope of Analysis" section in the "Purpose of and Need for Action" chapter for a more detailed description of the area evaluated in this document) including the core elk winter range areas, Kawuneeche Valley, and alpine areas, as these are the areas most affected by potential activities and primary habitats for elk in the park. Cumulative effects that would occur both inside and outside these areas were evaluated using the methods described in the "Cumulative Analysis" section.

Issues

Issues that were identified during internal and public scoping regarding elk and vegetation management activity effects on other wildlife include the following:

- The long-term response of other wildlife species' populations to the foraging effects of the present elk population sharing/cohabiting the elk primary winter range portions of the park.
- The potential for transmission of disease (e.g., chronic wasting disease) to mule deer or moose may be related to the prevalence of chronic wasting disease in elk.
- Changes in species diversity, abundance of wildlife, and biodiversity in the habitats within the elk primary winter and summer ranges, particularly in those portions of the range that are degraded as a result of elk foraging.
- Availability and alteration of habitat for wildlife species on the elk primary winter and summer ranges.
- Behavior of wildlife species as a reaction to the existing conditions or the actions associated with any of the alternative's management actions.

Also, the public identified a need to address restoration of an intact ecosystem in addition to focusing on elk and vegetation. Within this context, the issue of habitat restoration to benefit all species rather than just elk was recognized. The public expressed a desire for actions taken under this plan to consider an ecosystem restoration-approach as a goal rather than addressing problems based on a species- or community-specific approach.

Assumptions

The following assumptions were used to assess elk and vegetation management actions on other wildlife species:

- The lack of beaver would contribute to changes in hydrology, which contributes to reduced willow, resulting in more herbaceous plant cover in montane riparian areas.
- The conversion of willow habitat to grassland results in a decline or loss of montane riparian corridor biodiversity.
- The limited number of carcasses that would be left in the field following lethal reduction actions of the elk populations would consist of calves only to minimize to the extent possible the potential for transmission of chronic wasting disease (Wild 2005).
- Fencing would only restrict the movements of elk and moose; other wildlife would not be restricted by fences.
- The management of the released wolf population would be successful and stages subsequent to the initial phase would be implemented. The analysis of effects of Alternative 5 was based on the impacts of a functioning population of not more than 14 wolves in the park.
- Wolves (either a released or naturally dispersing population) would prey primarily on elk.

Actions that would result in an increase in the coyote population would be representative of non-natural conditions as the coyote population remains high due to a lack of a natural competitor.

Assessment Methods

Each alternative was assessed to determine the impacts of the actions on other wildlife species.

Primary steps for assessing impacts included identifying (1) the location of areas likely to be affected by the proposed alternatives and (2) potential changes in wildlife populations, habitat, or behavior from current and future elk and vegetation management actions. NPS management of wildlife is not based on single animals but rather focuses on the role of animal populations and species within the ecosystem (NPS 2006b). Therefore, the analysis and thresholds of impact intensity focus predominantly on the effects of management actions at the population level. The National Park Service recognizes that individuals within a population would be affected by management actions, and this is described in the analysis but without an associated intensity of effect. Impacts on individuals are described in the analysis, and those individual effects collectively contribute to population level effects.

To understand the effects of elk and vegetation management methods on other wildlife, park resource inventories and management plans, scientific literature, and published technical data were consulted to identify the information contained in this analysis.

Impact Threshold Definitions

Impacts intensity level thresholds were defined and evaluated as follows:

Negligible: Native wildlife species, their habitats, and the natural processes sustaining them would not be affected or the effects would be at or below the level of detection. Effects would be well within the range of natural fluctuations and would not be of any measurable or perceptible consequence to wildlife populations. Habitats would retain adequate ecological integrity to support native fish and wildlife species.

Minor: Effects on native species, their habitats, and the natural processes sustaining them would be detectable. Population numbers, structure, and other demographic factors may experience small changes, but the changes would not likely affect population viability. Habitats would retain adequate ecological integrity to support native fish and wildlife species.

Moderate: Effects on native species, their habitats, or the natural processes sustaining them would be readily detectable and likely have consequences at the population level. Population numbers, population structure, and other demographic factors for species may change, and the changes may affect the viability of a population. Habitats would retain adequate ecological integrity to support native fish and wildlife species.

Major: Effects on native species, their habitats, or the natural processes sustaining them would be easily detectable and would have consequences at the population level. Population numbers, structure (i.e., age or sex ratios), and other demographic factors would experience changes that would have an effect on the viability of a species. Habitats would be affected in a way that would change support for native wildlife.

Type of Impact

Beneficial impacts would result in wildlife populations whose size, density, and other population characteristics (e.g., age and sex ratios, survival, mortality, recruitment) would be within normal

parameters and in ecological balance with other resources. Behavior, habitat**,** necessary resources, migration, or dispersal characteristics would be supported by the action in question.

Adverse impacts would cause wildlife populations to experience negative effects with respect to size, density, and other population characteristics, as identified above. The proposed action would restrict or limit behavior, habitat, necessary resources, migration, or dispersal characteristics.

Duration: Short-term impacts would allow recovery in less than one year. Long-term impacts would require one year or more for recovery.

Impairment

Impairment of wildlife resources or values would occur if a permanent major adverse effect on wildlife and habitats affected a large portion of the park. The effect would be highly noticeable, could not be mitigated, and would affect wildlife and habitats to the point that enjoyment of the wildlife and habitat resource by future generations of park visitors would be precluded.

Alternative 1

This alternative would continue the existing management framework. No new management actions would be applied, and the park elk population would continue to be regulated by natural, currently existing processes, primarily forage availability and weather conditions. Under this alternative, the elk population is expected to fluctuate between 2,200 and 3,100 animals, which would be outside the natural range of variation estimated to be optimal. No formal framework for management of vegetation associated with elk (i.e., forage, cover, dominant species in elk habitat) within the park would be developed.

Wildlife Habitat

Under Alternative 1, the elk population would continue to forage on the core winter range at densities that would have an adverse effect on montane riparian habitat. Reductions in water availability, in combination with continued intense elk browsing, is contributing to a decline or loss of montane riparian willow and an increase in grassland (Coughenour 2002, Peinetti et al. 2001). This trend would continue and result in a long-term, local-to-regional, minor-to-major adverse effect on other wildlife species that use montane riparian willow habitat. If breeding populations of wide-ranging species are affected, the impacts could extend regionally, although it is more likely that the effects would be local in the case of range-limited species such as amphibians and small mammals. Those generalist species that do not rely exclusively on montane riparian willow habitats would experience effects at the minor end of the range, while species that rely on montane riparian willow, such as beaver, would be adversely affected to a major degree.

Biodiversity, including the ecological processes associated with the complement of species present (e.g., niche occupation, foraging effects on primary productivity), would experience a long-term, local-to-park-wide, moderate, adverse effect as a result of habitat changes associated with Alternative 1. The adverse effect is primarily related to degradation of montane riparian willow and aspen communities in high-use areas on the elk primary winter range and in the Kawuneeche Valley. The changes of the montane riparian willow and aspen communities in these areas (see the "Vegetation" section for more detail about conditions in those communities) no longer provide for all the resource needs of a full complement of species associated with these

habitat types (e.g., reduction in nesting habitat for songbirds, lack of vegetation to support butterfly species, insufficient forage for beaver).

Currently, fenced research exclosures limit habitat availability for wildlife in approximately 12 acres. This represents a long-term, local, negligible, adverse effect on large wildlife species whose movements are restricted by the fences as a result of loss of habitat. Small mammals, birds, amphibians, and insects that can easily move through the fences would not be affected.

Ungulates

Competition with elk for forage and habitat can restrict the population size and distribution of other ungulates (i.e., mule deer, bighorn sheep, moose) in the park (Coughenour 2002). In particular, competition with elk may be limiting the availability of browse for mule deer (Hobbs et al. 1996a, Hobbs et al. 1996b, CDOW 1999), resulting in a park-wide, long-term, moderate, adverse effect on deer.

Competition between elk and bighorn sheep is limited and does not likely affect bighorn to an appreciable degree, although elk are capable of displacing sheep from preferred foraging areas in the park (Goodson 1978). Such displacement could result in long-term, local, negligible adverse effects on bighorn sheep if sheep are restricted from preferred foraging grounds.

There is uncertainty regarding the potential impact of elk on moose. The species do share common diet items, and they share foraging habitat in summer, especially in the Kawuneeche Valley. However, the historical presence of moose and their ecological role within the park is not well understood (Monello et al. 2005). Competition between elk and moose for habitat and forage does occur, but more research is necessary to determine the ultimate effects of continuing current elk management on moose. Studies in other locations have shown that moose are not tolerant of large groups of elk and maintain separation in their distribution (Peek and Lovaas 1968, Jenkins and Wright 1987). This would be true in Rocky Mountain National Park only if summer forage is a limiting factor.

High concentrations of elk would likely contribute to direct intraspecific, and potential interspecific environmental transmission (Miller et al. 2004) of chronic wasting disease to deer or moose. This would represent a long-term, park-wide, minor-to-moderate, adverse effect on ungulates susceptible to chronic wasting disease.

Predators and Scavengers

The effects of elk and vegetation management actions on mountain lion, black bear, coyote, red fox, bobcat, common raven, black-billed magpie, turkey vulture, and other carnivorous species and scavengers are addressed in this subsection.

The current elk population in the park provides prey for the mountain lion, although the lion's preferred prey is mule deer (Hornocker 1970, Kunkel et al. 1999). The availability of elk as a prey item with a large, easily located population represents a negligible-to-minor, long-term, regional benefit to the mountain lion.

Black bears are omnivorous and primarily scavenge elk although they are capable of taking live elk calves (Knight et al. 1999, Smith and Anderson 1996). Research has not found elk to be a part of the black bear diet in the park (Zeigenfuss 2001). As a result, current management of elk and vegetation would not have an effect on black bear.

Coyotes are abundant in the park and eat a mixed diet, with small mammals predominant, but the coyote diet does include birds, carrion, and large mammals (Nowak 1991). In a study of elk calf

mortality in the park and the vicinity of Estes Park, Bear (1989) reported that 17% of calf mortality could be attributed to coyote predation. While the presence of a large elk population appears to benefit the coyote in the form of an easily accessible prey source, the decline or loss of willow habitat in the core winter range has affected small mammal and songbird populations as willow habitat has been converted to grassland. In combination these would result in no net effect.

Red foxes would be affected in similar fashion because of the adverse effect on small mammal and bird populations. The impact of continuing current management would likely have a negligible adverse effect on the red fox.

Although a bobcat may occasionally take an elk calf or an unhealthy adult elk, it is neither typical nor likely. The bobcat's preferred diet consists of small mammals, such as rabbits and rodents, and birds. Although the reduced populations of small mammals and songbirds as a result of habitat changes in the montane riparian willow community could have a long-term adverse affect on prey availability for the bobcat, the effect would likely be local and negligible.

Scavengers rely on carrion as a primary diet item. The relatively high elk population in the park winter core range provides numerous carcasses for bears, coyotes, ravens, black-billed magpies, turkey vultures, jays, and other species that consume carrion. The continued high elk population in the park would represent a long-term, regional, minor benefit to scavenger species' populations as a result of an easily available food source.

Small Mammals

The high elk population and high rates of herbivory, in combination with a lower water table and less aquatic habitat in areas where montane riparian communities once thrived, has caused a shift in small mammal populations. Generally, specialist species that make use of wetlands and montane riparian habitats have been displaced by species that rely more on grassland habitat as community types have changed. The change in community type as a result of elk foraging has reduced the structural complexity of available habitat and in turn reduced available resting, breeding, and hiding cover for small mammals (Medin and Clary 1989, Medin and Clary 1990b). This would represent a long-term, local, minor, adverse effect on small mammals.

Beaver

The effects on beaver are addressed here separately from other mammals because of the interactions between beaver, elk, willow, and hydrology on the elk primary winter range and the Kawuneeche Valley, and because of the beaver's role as a keystone species (Naiman et al. 1988). The relationships between elk and beaver, or more specifically, the lack of beaver in the elk primary winter range, have contributed, in part, to the ongoing changes and degradation of the willow community (Baker et al. 2005). The low beaver population in the park has reduced the ecosystem manipulation effects typically associated with beaver (i.e., dams, ponds, and elevated water table) that has in turn led to a reduction in suitable willow habitat. At the same time, high elk densities in the core winter range and the associated high rates of willow herbivory by elk have limited willow availability for beaver. This has led to a negative feedback loop where continued high elk densities inhibit the potential for the beaver population to rebound from past effects of trapping (Baker et al. 2005). The effect of continued high elk densities and high rates of willow and aspen herbivory by elk on beaver would be long term, local, moderate to major, and adverse.

Birds

Avian species affected by elk and vegetation management activities are grouped into the following categories to facilitate the discussion of effects: white-tailed ptarmigan, raptors, songbirds and cavity nesters, and waterfowl/shorebirds.

Continued limitations on aspen regeneration and a conversion of willow habitats from mixed tall and short willow to predominantly short willow would result in a local-to-regional, long-term, moderate adverse effect on avian biodiversity. Once again, the extent of the effect would depend on the range of the species affected and its degree of reliance on aspen and willow. This effect is primarily related to the decline or loss of habitat and habitat structure. In the case of aspen, as stands age without regeneration, the proportion of dead trees to live ones increases, with a commensurate loss of preferred cavity-nesting habitat (Zaninelli and Leukering 1998; Duberstein 2001). As willow stands become shorter, avian species that typically prefer a mix of tall and short willow structure would be adversely affected (Zaninelli and Leukering 1998, Leukering and Carter 1999, Duberstein 2001).

White-tailed Ptarmigan could be affected by high elk populations and a continuation of current management if elk herbivory limits the forage available to ptarmigan in alpine habitats as postulated by Braun et al. (1991). This would represent a long-term, local, minor-to-moderate, adverse effect on the ptarmigan population in the park. However, Wang (2002a) reports that fluctuations in ptarmigan populations in the park are a result of local weather patterns rather than effects of competition with elk. Based on the later research, there may be no direct effect of continued elk populations on ptarmigan. Additional research is necessary to determine the potential future effects of current elk management on ptarmigan populations in the park.

Raptors, including several species of hawks, accipiters, owls, and eagles, would primarily be affected by elk and vegetation management activities as a result of actions that affect their prey base. In addition, improvements in habitat would provide increased roosting and nesting habitat for small owls, particularly those in aspen. The most common prey items for raptors include small mammals and songbirds, with a low incidence of scavenging on carrion in the park by bald and golden eagles. As a result of the changes in habitat structure, the conversion of montane riparian willow habitat to grassland would benefit raptors that prey on small mammals. Foraging would be more efficient in open grassland compared to dense willow thickets. This would represent a long-term, local, negligible-to-minor benefit for raptors preying on small mammals that use grassland habitats. On the other hand, accipiters that prey on birds, especially songbirds that nest or use willow habitats, would experience a long-term, local, minor-to-moderate, adverse effect because their prey base would be reduced as the result of the continued degradation and conversion of montane riparian willow habitat. Scavenging raptors, including bald and golden eagles, would continue to find carrion in the park, resulting in a long-term, local-to-park-wide, minor benefit.

Songbirds and cavity nesting birds use aspen, montane riparian willow, and ponderosa pine habitat in the park (Connor 1993, Turchi et al. 1994), with montane riparian willow habitat having high avian species diversity compared to its areal extent (less than 4% of the park). Leukering and Carter (1999) found that different bird species in the park used different sizes and densities of willow, indicating that short and tall willow are both important. Bird species richness is especially high in aspen (Turchi et al. 1994), and Zaninelli and Leukering (1998) and Duberstein (2001) suggested live aspen trees are more important to cavity nesting birds than dead aspen, and that different bird species used different sizes and densities of aspen. The conversion of tall willow to short willow, and the concurrent change from willow community to grassland associated with continued high elk foraging rates (and in combination with a lower water table) has an adverse effect on bird species richness and abundances for the species that rely on montane

riparian willow habitat for breeding, foraging, and roosting (Medin and Clary 1990b). Additionally, conditions in aspen, where regeneration is restricted by elk foraging and the age distribution of trees has shifted toward older trees, would also contribute to some loss of potential habitat for songbirds and cavity nesting species that prefer aspen. These adverse effects on songbirds and cavity nesting birds and their supporting habitat would be long term, local, and moderate to major.

Waterfowl and shorebirds rely on aquatic and montane riparian habitats during much of their life history (Terres 1980). The effects of a depressed beaver population and the commensurate decrease in beaver ponds, high elk foraging rates, and a conversion of montane riparian willow habitat to grassland all contribute to a decline or loss of habitat for waterfowl and shorebirds in the core winter elk range and may result in an increase in predation of nests due to a decline or loss of cover. This represents a long-term, local, minor-to-moderate, adverse impact on waterfowl and shorebirds.

Upland shrub birds would be affected by current management of elk and vegetation to the degree that elk herbivory, combined with foraging by other ungulates, primarily mule deer, affects the integrity of upland shrub habitat. Singer et al. (2002) found that annual herbaceous consumption rates in upland shrub communities averaged 60%, which has the potential to alter herbaceous communities in the park. As a result, because of changes to upland shrub communities, there would be long-term, local, minor-to-moderate, adverse effects on bird species that rely on that habitat.

Fish

The continued degradation of montane riparian willow habitat would affect aquatic habitat that supports several trout species, primarily on the elk primary winter range where the impacts on montane riparian willow habitat are greatest, although the effects would likely occur in the elk primary summer range in the Kawuneeche Valley as well. The decline or loss of montane riparian willow cover along waterways can raise stream temperature, reduce litterfall, and contribute to streambank erosion, all of which would adversely affect fish species inhabiting creeks and rivers in the elk primary winter and summer ranges (Schulz and Leininger 1990, Fleischner 1994). These adverse effects would be long term, local, and minor.

Amphibians and Reptiles

The loss and conversion of wetland, aquatic, and riparian habitats to habitats (i.e., grassland or upland) would continue under current management. The lowered water table, partly a result of the depressed beaver population, and continued high levels of elk foraging would contribute to these habitat losses and conversions. Each of these habitat types provide the resources that amphibian species rely on. The effects on amphibian habitat would represent a long-term, local, moderate, adverse effect on amphibians in the elk range. Physical impacts on individual amphibians could include trampling as a result of high elk densities in wetlands and riparian habitats.

Continuing current management would affect montane riparian habitat as described above. As a result, the only reptile species in the park, the Western terrestrial garter snake, would experience long-term, local, minor, adverse effects as a result of habitat loss and conversion.

Butterflies

The continued degradation of montane riparian willow habitat, conversion of willow to grassland, and the adverse impacts high levels of elk herbivory on aspen would result in a long-term, local, minor-to-moderate, adverse effect on butterflies. Butterfly species diversity, richness, and uniqueness would likely decline as a result of the habitat changes that continue to take place in aspen and willow (Simonson et al. 2001).

Cumulative Impacts

In recent years, low-flying commercial air tours over the park and the use of snowmobiles on Trail Ridge Road have been banned. Wildlife vary in their responses to noises, but it can negatively affect many species through changes in behavior and physiological effects (USAF and USFWS 1988). These bans represent a long-term, regional, minor, beneficial effect for wildlife.

A number of actions in the park and on adjacent lands are targeted on improving forest health by controlling the pine bark beetle and managing forest fuels through mechanical thinning and prescribed fire. These activities would adversely affect wildlife as a result of temporary displacement and short-term alteration of wildlife habitat, representing a short-term, minor, adverse effect. With mitigation measures in place, some, but not all, snags would be left in place for cavity nesters, resulting in a long-term, minor, adverse effect. However, overall, these actions would result in long-term, minor, beneficial effects on wildlife, as a result of improved habitat.

A series of construction and trail projects would temporarily displace wildlife and permanently remove relatively small portions of habitat. The effects of these projects would be both short term, minor, and adverse and long term, negligible, and adverse.

Management plans for protecting the park's natural resources would benefit wildlife, by maintaining and restoring natural conditions and limiting intrusive activities. Effects associated with these management plans would be long term, minor-to-moderate, and beneficial. Restoring vegetative communities and removing exotic plants in the park would also enhance wildlife habitat, a long-term, minor, beneficial effect on wildlife. Although some bird species may use exotic species (e.g., songbird use of thistle seed), control of exotic plant species would restore ecosystem integrity and provide a cumulative benefit.

Restoration of a native fish species in the park would reduce non-native species and enhance aquatic habitats in the long term, a minor-to-moderate benefit, but would also potentially involve the use of piscicides, which could remove aquatic life in short reaches of streams, resulting in a short-term, moderate, adverse effect.

Activities outside the park also affect wildlife species within the park, as individuals outside can be part of the same population as those within the park. Development in the Estes Valley and in other areas outside the park would continue to fragment and reduce wildlife habitat outside the park, a long-term, regional, moderate-to-major, adverse effect. Hunting and fishing outside of the park would continue to be managed so that habitat conditions are not degraded by overpopulation of species that may grow in the absence of predators. Game management outside the park would help maintain habitat quality for wildlife populations that share habitat inside and outside the park and would represent a long-term, regional, minor-to-moderate benefit for wildlife.

Alternative 1 would generally contribute long-term, moderate, adverse effects on the cumulative impacts on wildlife as a result of adverse effects on habitats affected by elk. In general, over the area addressed in this plan, the cumulative effects on wildlife from these other plans, projects, and actions and from Alternative 1 would be short-term and long-term, regional, minor-to-moderate, and adverse, primarily as a result of changes to, and losses of, wildlife habitat.

Conclusion

Wildlife species on the elk primary winter and summer ranges in Rocky Mountain National Park would be affected by Alternative 1 in various ways and degrees. Effects would vary extensively depending on species and locations. The most common and widespread effect within the core winter range would be related to loss of and changes to montane riparian willow and aspen communities and the wildlife habitat resources in those communities. These adverse effects would be expected to continue into the future under Alternative 1.

The range of adverse effects associated with habitat changes would be negligible for bighorn sheep, moose, and bobcat; minor for most small mammals, and fish; minor to moderate for mule deer, butterflies, upland shrub birds, waterfowl and shorebirds; moderate for amphibians and reptiles; and moderate to major for beaver and for songbirds and cavity nesters. Adverse effects associated with forage competition between elk and white-tailed ptarmigan may occur at a minor-to-moderate intensity; however, some research indicates that ptarmigan populations are not affected by elk herbivory and that other factors (e.g., weather) may be more decisive in regulating ptarmigan populations.

Beneficial effects on wildlife that result from continuing current management would range from negligible to minor for mountain lions and for raptors that forage in grasslands to minor for scavenger species that rely on carrion, including bald and golden eagles.

The small scale of the long-term, moderate, adverse effects of Alternative 1 would have little effect on the overall short- and long-term, minor, adverse, cumulative effects on wildlife that would occur under Alternative 1.

Using the impairment analysis criteria presented in the beginning of this section, there would be no impairment of wildlife values or resources as a result of implementing Alternative 1.

The beneficial or adverse nature and the intensity of the effects for wildlife species as a result of implementing Alternative 1 are summarized in Table 4.1.

TABLE 4.1: SUMMARY OF IMPACTS OF ALTERNATIVE 1 FOR WILDLIFE

Species/Group	Adverse or Beneficial Effect	Intensity of Effect
Mule deer	Adverse	Moderate
Moose	Adverse	Negligible
Bighorn sheep	Adverse	Negligible
Mountain lion	Beneficial	Negligible to minor
Coyote	No effect	No effect
Red fox	Adverse	Negligible
Black bear	No effect	No effect
Bobcat	Adverse	Negligible
Scavengers	Beneficial	Minor

TABLE 4.1: SUMMARY OF IMPACTS OF ALTERNATIVE 1 FOR WILDLIFE (CONTINUED)

Species/Group	Adverse or Beneficial Effect	Intensity of Effect
Small mammals (most)	Adverse	Minor
Beaver	Adverse	Moderate to major
Ptarmigan	Adverse (uncertain)	Minor to moderate (uncertain)
Songbirds	Adverse	Moderate to major
Cavity nesting birds	Adverse	Moderate to major
Raptors	Adverse (accipiters) Beneficial	Minor to moderate Negligible to minor
Waterfowl and shorebirds	Adverse	Minor to moderate
Upland shrub birds	Adverse	Minor to Moderate
Fish	Adverse	Minor
Amphibians and reptiles	Adverse	Minor to moderate
Butterflies	Adverse	Minor to moderate

Alternative 2

Alternative 2 would involve agency removal of elk using lethal means, with aggressive reduction targets within the first four years of the plan to quickly reduce the size of the population, followed by less intensive yearly reductions to maintain target populations. The target elk population would fluctuate between 1,200 to 1,700 elk, which is on the lower end of the natural range of variation of 1,200 to 2,100 elk. Up to 160 acres of aspen (105 acres in winter elk range and 55 acres in summer elk range) would be fenced in a phased manner as needed based on monitoring of vegetation response to protect the stands from elk herbivory and to allow regeneration of aspen. Elk redistribution techniques would be used to better attain vegetation restoration objectives, primarily in montane riparian willow communities, by dispersing locally high concentrations of elk. A research study would be undertaken in the first three years of the plan to evaluate procedures for testing live elk for chronic wasting disease.

Wildlife Habitat

Fencing aspen in elk primary winter and summer ranges would represent a moderate, local, long-term benefit to wildlife as the reduction of elk herbivory would allow aspen to regenerate and would restore the diversity of tree size in aspen stands. The proportion of live to dead aspen trees would increase as new trees regenerate. This diversity is important to avian species (Zaninelli and Leukering 1998, Duberstein 2001) that use aspen for cavity nesting as well as species that forage and nest in the canopies of aspen trees. Moose access to the fenced aspen stands on the

primary summer range would be restricted by the fences, resulting in a long-term, local, negligible adverse effect on moose, as some preferred foraging areas would not be available. Redistribution actions that would target concentrations of elk have some potential to negatively affect individuals of other wildlife, but the disturbance would be short term and localized. Redistribution actions would be restricted during known sensitive portions of species' life cycles or in sensitive locations (e.g., breeding or nesting seasons, migration corridors, nesting habitat) to avoid and minimize potential adverse effects.

Biodiversity would experience a long-term, local, moderate-to-major benefit as a result of habitat restoration, particularly in aspen and willow communities.

The use of a capture facility to round up large numbers of elk for lethal reduction would require baiting or herding to get the elk into the facility. Herding could be accomplished using trained herding dogs, riders on horseback, people on foot with noisemakers or visual devices (such as sticks with streamers), or helicopters as an adaptive tool if necessary. The noise generated by these activities would negatively affect individuals of other wildlife species. The adverse effect of the capture facility on wildlife habitat would be short term, local, and up to minor, depending on the specific location and the habitat affected.

Wildlife would be affected by helicopter overflights that would transport fence material into the park, although wildlife would be expected to return to pre-disturbance numbers once the disturbance ends. This disturbance would represent a short-term, negative effect on wildlife species within the area of activity.

The research activities associated with evaluating procedures to test for chronic wasting disease in live elk would involve the capture or darting, anesthetizing, and handling of elk, which would be conducted in coordination with elk management activities and would have effects on wildlife similar to those associated with lethal control through darting. Wildlife would be disturbed as a result of noise associated with human presence and activities to capture, mark, test, and treat elk. These activities would have short-term, negative effects on individuals of a species but would not have effects at the population level. Research activities may also be accomplished when elk are captured through use of a capture facility or corral trap during elk management activities.

Ungulates

The aggressive reductions in the elk population during the first four years of this alternative would likely result in an increase in the mule deer population as a result of reduced competition (Coughenour 2002, Stevens 1980a) with elk. There would be a number of years before the reaction in the deer population would be fully realized and during the life of the plan, there would be a point when there would be no adverse effects on mule deer as the the forage base for deer would improve and competition for forage would be lessened. However as forage continues to improve, particularly in upland shrub communities, the deer population would increase to a level that would eventually result in overuse of forage and increased intraspecific competition. In the long-term, larger deer populations and higher densities would contribute to an increased risk of transmission for chronic wasting disease. This would represent a long-term, park-wide, minor-to-moderate adverse effect on the mule deer population. Redistribution actions that would target concentrations of elk have some potential to adversely affect mule deer, but the disturbance would be short-term, local, and negligible to minor. The effects on deer would not be substantial because mule-deer-preferred habitat would not likely be targeted by redistribution efforts.

Although the level of competition between elk and moose is not completely understood, it is likely that a substantially reduced elk population and an accompanying reduction in foraging in

montane riparian willow habitat would improve the amount and quality of willow forage. This would result in a long-term, local, minor benefit to moose.

Redistribution actions taken to reduce concentrations of elk have the potential to affect moose. Although redistribution techniques would target high concentrations of elk, the actions may inadvertently affect moose because they may share montane riparian habitats with elk, particularly in the elk primary summer range. Similarly, lethal control actions could affect moose because of the presence of control personnel and the activities. If helicopters were needed to facilitate removal of carcasses from remote locations due to disease management concerns, the negative effect on moose would be short term and would occur over a wider area than what would be affected by ground crews only. These activities would result in short-term, negative effects while the activities were occurring.

Generally, competition between elk and bighorn sheep is minimal with respect to the use of range and in terms of each species' preferred forage (Capp 1967, Capp 1968, Harrington 1978, Singer et al. 2002). However, the elk population has grown considerably since Capp and Harrington's research, and Goodson (1978) did report that elk can displace bighorn sheep from preferred foraging areas. As a result, large and relatively quick (i.e., in the first four years) reductions in the elk population associated with Alternative 2 would benefit bighorn sheep in a long-term, local, negligible manner.

Lethal control activities, as well as redistribution techniques to disperse high concentrations of elk, would not take place in areas where bighorn sheep are present. Because sheep are relatively sensitive to disturbance, and other factors such as disease increase sheep's susceptibility to adverse effects of disturbance, lethal control and redistribution actions targeting elk could have negative effects on individual sheep. After the first four years, the potential for control activities to have negative effects on individual sheep would decrease incrementally as the magnitude of lethal elk control declined to maintenance levels.

If the intense elk reduction actions require the use of corral traps, there could be negative effects on bighorn sheep as a result of baiting techniques used to attract elk to the traps. These potential negative effects would be mitigated by limiting the baiting locations to avoid areas known to be frequented by bighorn sheep, and implementing lethal elk reduction actions quickly to minimize the number of days that bait would be used. This potential for negative effects would only exist during the first four years of the plan, as reduction efforts would not likely need traps during the maintenance phase (years five through 20) of the plan.

Fences around aspen stands would have a long-term (for the duration of this plan or as long as fences remain), local, negligible-to-minor, adverse effect on moose, and possibly bighorn sheep, if they have difficulties passing under the lowest strand of wire, because areas that contain preferred forage or habitat may be inaccessible.

Predators and Scavengers

The large and relatively rapid reduction in the size of the elk population associated with Alternative 2 would likely result in an increase of the mule deer population over time as competition between deer and elk declined. This would provide an increased deer prey base for individual mountain lions with territories in the park and result in a long-term, local-to-park-wide, negligible benefit to the mountain lion population, as deer would be easier for lions to prey on than elk. This benefit could be offset by a reduction in the prey base for those mountain lions that have come to rely on elk as a substantial portion of their diet, although the availability of habitat likely has more effect on mountain lion populations when prey is abundant (Hunter 2005), as is the case in the park. On balance, the elk reductions would offset the increase in deer, resulting in

no effect with regard to prey availability for mountain lions in the park. However, the general improvement in habitat across the elk primary winter and summer ranges would provide some benefit to mountain lions and result in a long-term, local-to-park-wide, negligible benefit. The presence of fences around aspen stands would not have an appreciable effect on the mountain lion, nor would lethal reduction activities, because of the lion's wide-ranging nature and the low lion densities in the park.

Black bear would not be affected by the reduction in elk in terms of prey availability, although lethal reduction activities could disturb individual bears and result in temporary displacement from habitat. There could be a long-term, local, negligible-to-minor benefit to bears as a result of an increase in carrion as elk calf carcasses would be left in the field following lethal reductions. As the intensity of lethal reduction activities would decrease after year four, the effects of disturbance (adverse) would diminish to a negligible level.

Red fox would experience a range of effects as a result of the implementation of Alternative 2. With the restoration of montane riparian willow habitat, there would likely be more foraging opportunities for foxes, as the willow habitat would likely support more small mammal and bird species than grasslands. This would have a long-term, local, minor benefit for these predators. There could be offsetting adverse effects if increased prey availability results in an increase in coyote populations because of competition between the species. An increase in carrion as a result of intensive lethal reduction actions would have a local, minor benefit for the red fox and other scavenger populations during the first four years of the plan. The benefit would become undetectable after the first four years of the plan, as lethal control actions to maintain the elk population at target levels would decrease substantially. An increase in foraging opportunities with the restoration of montane riparian willow habitat and an increase in available carrion in the first four years of the plan as described above could result in an increase in the coyote population. This increase in population, however, could be outside the range of natural conditions expected in the presence of a natural competitor (wolves) and therefore would represent a long-term, local, minor, adverse impact.

Small mammal prey in restored montane riparian willow habitat would have a long-term, local, negligible benefit for bobcat because the species diversity and availability of structural cover would likely increase foraging opportunities.

Scavengers rely on carrion as a primary diet item. The elk population provides carcasses for bears, ravens, black-billed magpies, turkey vultures, jays, and other species that consume carrion. Leaving some elk carcasses in the field would represent a long-term, park-wide, minor benefit to scavenger species' populations as a result of an easily available food source.

Small Mammals

Small mammal populations other than those that use grasslands would benefit from the restoration of montane riparian willow habitat as more vegetation and structural diversity would provide additional cover for hiding, resting, and breeding. This would result in long-term, local, minor benefits for small mammals. Fencing of aspen and lethal elk reduction activities would not likely have an effect on small mammals.

Beaver

The relatively rapid reduction in elk population would aid in achieving the vegetation restoration objectives of the management plan. As montane riparian willow habitat in the elk primary winter range recovers, recovery of the beaver population would be possible, either as a natural process

(albeit slow as beaver reproduction rates are slow) or by reintroduction of beaver when at least 10 acres of restored willow has been sustained for two seasons. This would represent a long-term, local, moderate benefit for beaver. Likewise, an increase in the beaver population and their alteration of aquatic, wetland, and montane riparian habitats would result in long-term, local, minor-to-moderate benefits for wildlife species associated with those habitats.

Birds

In general, fences around aspen could potentially negatively affect individual birds as a result of collisions and entanglement.

White-tailed ptarmigan would experience a long-term, local, minor-to-moderate benefit as a result of the reduced elk population. The benefit would be associated with a reduction in competition for forage on alpine habitat. This beneficial effect may be undetectable if competition for forage between elk and ptarmigan is not an important factor as a population-regulating mechanism for ptarmigan (Wang 2002a).

Raptors would benefit from the reduction in elk population indirectly, as the restoration of montane riparian willow habitat would contribute to a more natural and complete ecosystem. The restoration of montane riparian willow habitat would enhance diversity and robustness of potential prey populations. Although foraging may be more challenging in the more structurally complex willow habitat than in grassland, the overall improvement in prey species diversity and richness would be a long-term, local, minor-to-moderate benefit for raptors.

Scavenging raptors, including bald and golden eagles, would benefit from some carcasses left in the field as a result of lethal elk reduction actions; the benefit would be long term, local to park-wide, and minor.

Songbirds and cavity nesting birds would benefit from the restoration of montane riparian willow habitat as elk herbivory would decrease with the intensive elk population reductions. The fencing of aspen would, over time, allow regeneration of aspen and a more even distribution of age classes that would benefit cavity nesting birds that prefer live aspen trees (Zaninelli and Leukering 1998, Duberstein 2001). The increases in availability of habitat as willow communities recover would represent a long-term, local, moderate-to-major benefit to songbirds. Similarly, the benefits to cavity nesting birds would also be long-term, local, and moderate to major as the proportion of live to dead trees would increase in aspen stands as a result of regeneration.

Waterfowl and shorebirds that rely on aquatic and montane riparian habitats during much of their life history would benefit from the restoration of montane riparian willow habitat and the eventual recovery or reintroduction of beaver. A recovered beaver population would increase the areal extent of ponds and of aquatic and montane riparian habitat, providing more breeding and foraging habitat. The benefits would be long term, local, and minor to moderate.

Upland shrub birds would be affected under Alternative 2 by levels of elk herbivory, combined with foraging by other ungulates, primarily mule deer, and the resulting effect on upland shrub habitat. In the short-term, the reduction in elk foraging pressure may have a minor, local beneficial effect on upland shrub habitat and the bird species that rely on that habitat because of reduced foraging pressure. However, a reduction in the size and density of the elk population would likely result in an increase in the deer population. This could, in turn, increase herbivory pressure on upland shrub habitat, likely causing a long-term, local, minor-to-moderate, adverse effect on upland bird species. This effect may not occur during the initial stages of management, as the increase in the deer population may be delayed.

Fish

Restoration of montane riparian willow along the streams in the core winter elk range would lower stream temperatures, provide additional cover (which may decrease sediment in streams), and stabilize banks. These effects would represent a long-term, local, minor benefit to fish as the habitat variables would be better suited to the life history needs of native fish species.

Amphibians and Reptiles

The restoration of montane riparian willow habitat and eventual recovery or reintroduction of beaver would enhance aquatic, wetland, and montane riparian habitat. This would represent a long-term, local, minor-to-moderate benefit for amphibians and the Western terrestrial garter snake, the only reptile species in the park. These benefits would accrue as a result of increased habitat and resources that these species rely on.

Butterflies

Management actions associated with Alternative 2 would increase plant species richness in aspen and riparian herbaceous communities. This increase would lead to a corresponding increase in the diversity and species richness of butterflies. Restoration of willow communities also would provide additional foraging opportunities for butterflies. These effects would be long term, local, and moderately beneficial for butterflies.

Cumulative Impacts

The existing effects of other plans, projects, and actions on wildlife would be the same as described for Alternative 1: short- and long-term, moderate, and adverse. Overall other wildlife populations are affected most predominantly by the habitat alterations that are creating adverse effects. Adverse effects of aerial overflights, forest management activities, small-scale construction projects in the park, and development outside of the park contribute somewhat to the overall moderate, adverse effects of habitat alteration. Management plans within the park are providing benefits to wildlife populations; however, these benefits are outweighed by the moderate, adverse cumulative effects discussed in Alternative 1 cumulative analysis.

Some of Alternative 2's contribution to cumulative effects would be long term, moderate, and beneficial, while others would be short term, moderate, and adverse. The cumulative effects of other plans, projects, and actions combined with the effects of Alternative 2 would continue to be long-term, moderate, and adverse.

Conclusion

Relative to Alternative 1 (future baseline condition), this alternative would have the following effects on wildlife resources.

Wildlife species on the elk primary winter and summer ranges in Rocky Mountain National Park would be affected by Alternative 2 in numerous ways and to varying degrees. The most common effects would be related to restoration of montane riparian willow, aquatic, wetland, and aspen communities.

Wildlife would be affected by helicopter overflights that would transport fence material into the park. This disturbance would represent a short-term, localized, negative effect on individuals of wildlife species in the area of activity.

Negative effects associated with lethal elk reduction actions and carcass removal would result in short-term impacts on wildlife in the form of potential disturbance and temporary displacement. Additional long-term, local, negligible-to-minor adverse effects would be associated with fences around aspen stands for moose and possibly bighorn sheep. Minor-to-moderate, adverse effects on mule deer and upland shrub birds would be associated with increases in the deer population. The adaptive use of helicopters to remove elk carcasses due to disease management concerns would have negative effects on individuals of all wildlife species in the vicinity of operations during the first four years of the plan.

Restored habitats would benefit wildlife species, with the magnitude of the benefits being negligible for bighorn sheep, mountain lion, and bobcat; negligible to minor for black bear; minor for moose, red fox, scavengers, small mammals, raptors, upland shrub birds, and fish; minor to moderate for ptarmigan, waterfowl and shorebirds, and amphibians and reptiles; moderate for beaver and butterflies; and moderate to major for songbirds and cavity nesters. There would be minor adverse effects on coyotes as the population would increase outside of natural conditions as result of increased prey and carrion.

Research activities done in concert with elk management actions would negatively affect individuals of wildlife species while activities were taking place but would not have population level effects. Use of a capture facility under this alternative for elk management activities would have up-to-minor adverse effects on wildlife habitat.

The cumulative effects of other plans, projects, and actions combined with the effects of Alternative 2 would continue to be long-term, moderate, and adverse.

Using the impairment analysis criteria presented in the beginning of this section, there would be no impairment of wildlife values or resources as a result of implementing Alternative 2.

The beneficial or adverse nature and the intensity of the effects for wildlife species as a result of implementing Alternative 2 are summarized in Table 4.2.

TABLE 4.2: SUMMARY OF IMPACTS OF ALTERNATIVE 2 FOR OTHER WILDLIFE SPECIES

Species/Group	Adverse or Beneficial Effect	Intensity of Effect
Biodiversity	Beneficial	Moderate to major
Mule deer	Adverse	Minor to moderate
Moose	Adverse (aspen fencing, reduction and redistribution actions) Beneficial (habitat restoration)	Negligible to minor Minor
Bighorn sheep	Beneficial (habitat restoration)	Negligible
Mountain lion	Beneficial	Negligible
Red fox	Beneficial	Minor
Coyote	Adverse	Minor
Black bear	Beneficial	Negligible to minor

TABLE 4.2: SUMMARY OF IMPACTS OF ALTERNATIVE 2 FOR OTHER WILDLIFE SPECIES (CONTINUED)

Species/Group	Adverse or Beneficial Effect	Intensity of Effect
Bobcat	Beneficial	Negligible
Scavengers	Beneficial	Minor
Small mammals	Beneficial	Minor
Beaver	Beneficial	Moderate
Ptarmigan	Beneficial	Minor to moderate
Songbirds	Beneficial	Moderate to major
Cavity nesting birds	Beneficial	Moderate to major
Raptors	Beneficial	Minor to moderate
Waterfowl and shorebirds	Beneficial	Minor to moderate
Upland shrub birds	Adverse (increased deer in long-term) Beneficial (reduced elk in short-term)	Minor to Moderate Minor
Fish	Beneficial	Minor
Amphibians and reptiles	Beneficial	Minor to moderate
Butterflies	Beneficial	Moderate

Alternative 3

Alternative 3 relies on gradual lethal reduction of elk over time to regulate the elk population and its distribution. Because this alternative would maintain the elk population at the higher end (1,600 to 2,100 elk) of the natural range of elk population variation (1,200 to 2,100), up to 260 acres of fencing would be installed in montane riparian willow communities on the primary winter range and 180 acres on the primary summer range. Fence installation would be done in a phased approach commensurate with elk reductions, and elk redistribution techniques would be used to a greater degree to support vegetation restoration objectives outside fenced areas. Aspen would be fenced as in all action alternatives (up to 160 acres). A research study would be undertaken in the first three years of the plan to evaluate procedures for testing live elk for chronic wasting disease and evaluating the efficacy of a fertility control agent in free-ranging elk.

Wildlife Habitat

The installation of fencing in montane riparian willow communities and in areas where willow communities would have the potential to become reestablished would restrict access to preferred

foraging areas for elk and moose. The fence design would allow other species, including deer, to pass under the fence, thus having only a short-term, local, minor, adverse effect on most wildlife species as a result of potential problems in passing under the fence or possible entanglement. Fencing in willow habitat would represent a long-term, local, minor, adverse effect for moose because they would need to find other suitable areas to forage. However, the ultimate effect would result in range-wide, negligible benefits for moose as fencing was removed and willow habitat was restored in the park.

Redistribution actions would be restricted during known sensitive portions of species' life cycles or in sensitive locations (e.g., breeding or nesting seasons, migration corridors, nesting habitat) to avoid and minimize potential adverse effects. Redistribution actions targeting concentrations of elk would be used to a greater degree than in Alternative 2 because the target elk population would be larger. These actions have the potential to adversely affect all other wildlife, but the disturbances would be short-term, local, and minor and only incrementally greater that the effects described for Alternative 2.

Wildlife would be affected by helicopter overflights that would transport fence material into the park. This disturbance would represent a short-term, negative effect on individual animals in areas of activity.

The research activities associated with evaluating procedures for testing live elk for chronic wasting disease and effectiveness of a fertility control agent would be conducted within the framework of this alternative and would have effects similar to those described in Alternative 2. The administration of a fertility control agent to a small number of female elk by hand injection would have no effect on non-target animals.

General Effects of Alternative 3 on Wildlife

Lethal reduction of the elk population to the higher end of the range of natural variation would have effects on ungulates in the park similar to but incrementally less than Alternative 2 because of the less intense nature of the operations. Fewer crews would be needed to implement the reduction, and the effects of carcass removal would be substantially reduced. Ultimately, the negative effect of elk reduction actions on individuals of other wildlife species would be short term and localized. Unlike Alternative 2, the effects would not diminish after four years because the reduction actions would continue at the same level throughout the 20-year life of the plan. Helicopters would not likely be used because the number of carcasses to be removed could be handled using teams on the ground; however if due to disease management concerns it is found necessary to remove carcasses from remote locations, the impacts of helicopters on wildlife would be as described in Alternative 2.

Effects on bighorn sheep would be similar to those described for Alternative 2, although the lower elk reduction targets would cause a slightly smaller benefit with respect to lessened competition with elk for habitat. A capture facility would not likely be used to capture elk; thus, there would be no effect on bighorn sheep from baiting or to other wildlife from herding activities.

Fencing in willow habitat would represent a long-term, local, minor, adverse effect for moose because they would need to find other suitable areas to forage. However, the ultimate effect would result in park-wide, negligible benefits for moose when fencing was removed and the willow habitat restoration objective was achieved.

The effects of aspen fencing on wildlife would be the same as described for Alternative 2, as would the effects of fences around willow communities on avian species as a result of the potential for entanglement and collisions.

The effects of moderate lethal elk reductions and a corresponding increase in the deer population would have effects on the mountain lion similar to those described for Alternative 2. There would still be an adequate prey base for the lion and there would likely be no direct effect on the mountain lion, although the restoration of montane riparian habitat would represent a long-term, local, negligible benefit.

The overall effects of Alternative 3 on black bear, coyote, red fox, bobcat, other predators and scavengers, beaver, small mammals, ptarmigan, songbirds, cavity nesting birds, raptors, upland shrub birds, fish, amphibians, and reptiles would be similar to but incrementally less than those described for Alternative 2. This slightly lower increment would apply to adverse impacts as well as benefits, because while lethal elk reduction actions and the associated impacts would not be as intense or great, the degree of vegetation and habitat restoration would be neither as large nor as quick as under Alternative 2.

Exceptions to the similarity to Alternative 2 would be inside fenced areas of willow habitat, where the elimination of elk foraging would rapidly support vegetation restoration and quickly provide long-term, local, minor-to-moderate benefits to species reliant on and strongly associated with montane riparian willow habitat. Also, the beneficial effects on butterflies would be long term, local, and minor to moderate as overall willow habitat improvement would not be as widespread as under Alternative 2. Similarly, the benefits to waterfowl and shorebirds would be long-term, local, and minor to moderate as the amount of new aquatic, wetland, and montane riparian habitat created and the speed of the restoration would not be as great as under Alternative 2.

Biodiversity, measured using species richness parameters and including the ecological processes associated with the complement of species present (e.g., niche occupation, foraging effects on primary productivity, interactions between species), would experience a long-term, local-to-park-wide, moderate benefit as a result of habitat restoration, particularly in aspen and willow communities.

Cumulative Impacts

The existing effects of other plans, projects, and actions on wildlife would be the same as described for Alternative 1: short- and long-term, moderate, and adverse. Overall other wildlife populations are affected most predominantly by the habitat alterations that are creating adverse effects. Adverse effects of aerial overflights, forest management activities, small-scale construction projects in the park, and development outside of the park contribute somewhat to the overall moderate, adverse effects of habitat alteration. Management plans within the park are providing benefits to wildlife populations; however, these benefits are outweighed by the moderate, adverse cumulative effects discussed in Alternative 1 cumulative analysis.

Alternative 3's contribution would be similar to Alternative 2's, although less intense: long term, minor, and beneficial and short term, negligible to minor, adverse. The cumulative effects of other plans, projects, and actions combined with the effects of Alternative 3 would be continue to be long-term, moderate, and adverse.

Conclusion

Relative to Alternative 1 (future baseline condition), Alternative 3 would have the following effects on wildlife resources.

The effects on wildlife would be similar to, but in most cases incrementally less than, those described for Alternative 2 because the degree and speed of restoration would be less than under Alternative 2. Small decreases in the intensity of the benefit were predominant, although increased benefits were forecast for species that are reliant on or strongly associated with montane riparian willow habitat that would be fenced, where benefits would be long-term, local, and minor to moderate as a result of the relatively rapid habitat restoration.

Wildlife would be affected by helicopter overflights that would transport fence material into the park. This disturbance would represent a short-term, localized, negative effect on individuals of all wildlife species.

Research activities associated with procedures to test for chronic wasting disease in live elk and effectiveness of a fertility control agent would negatively affect individuals of wildlife species while activities were taking place but would not have population-level effects. There would be no effect on other wildlife from fertility control agents administered by hand to test subjects.

The cumulative effects of other plans, projects, and actions combined with the effects of Alternative 3 would be continue to be long term, moderate, and adverse.

Using the impairment analysis criteria presented in the beginning of this section, there would be no impairment of wildlife values or resources as a result of implementing Alternative 3.

The beneficial or adverse nature and the intensity of the effects for wildlife species as a result of Alternative 3 are summarized in Table 4.3.

TABLE 4.3: SUMMARY OF IMPACTS OF ALTERNATIVE 3 FOR WILDLIFE

Species/Group	Adverse or Beneficial Effect	Intensity of Effect
Larger wildlife	Adverse (fencing)	Minor
Species reliant on riparian willow	Beneficial	Minor to moderate
Biodiversity	Beneficial	Moderate
Mule deer	Adverse	Moderate to major
Moose	Adverse (aspen and willow fencing) Beneficial (habitat restoration)	Minor Negligible
Bighorn sheep	Beneficial (habitat restoration)	Negligible
Mountain lion	Beneficial	Negligible
Red fox	Beneficial	Minor

TABLE 4.3: SUMMARY OF IMPACTS OF ALTERNATIVE 3 FOR WILDLIFE (CONTINUED)

Species/Group	Adverse or Beneficial Effect	Intensity of Effect
Coyote	Adverse	Minor
Black bear	Beneficial	Negligible to minor
Bobcat	Beneficial	Negligible
Scavengers	Beneficial	Minor
Small mammals	Beneficial	Minor
Beaver	Beneficial	Moderate
Ptarmigan	Beneficial	Minor to moderate
Songbirds	Beneficial	Moderate to major
Cavity nesting birds	Beneficial	Moderate to major
Raptors	Beneficial	Minor to moderate
Waterfowl and shorebirds	Beneficial	Minor to moderate
Upland shrub birds	Adverse (increased deer in long-term) Beneficial (reduced elk in short-term)	Moderate Minor
Fish	Beneficial	Minor
Amphibians and reptiles	Beneficial	Minor to moderate
Butterflies	Beneficial	Minor to moderate

Alternative 4

Alternative 4 would use fertility control agents (single-year, multi-year, or lifetime duration) on elk inside the park to reduce and maintain the size of the elk population. Currently, due to the high number of elk that would need to be treated annually, it is logistically infeasible to meet the elk population objectives of the plan using only available fertility control agents. Therefore, the alternative involves the use of lethal reduction methods to supplement fertility control actions. Because this alternative would maintain the elk population at the higher end (1,600 to 2,100 elk) of the natural range of elk population variation (1,200 to 2,100), up to 260 acres of fencing would be installed around willow in the primary elk winter range in a phased approach commensurate with elk reductions, and elk redistribution techniques would be used to a greater degree to support vegetation restoration objectives outside of fenced areas. Aspen would be fenced as in all action alternatives (up to 160 acres). A research study would be undertaken in the first three years of the plan to evaluate the procedure for testing live elk for chronic wasting disease and evaluating the efficacy of a fertility control agent in free-ranging elk.

Wildlife Habitat

Fencing in aspen and willow communities would have effects on wildlife habitat and wildlife species similar to those described for Alternative 3.

General Effects of Alternative 4 on Wildlife

The effects of lethal reduction and redistribution actions would be the similar to those described for Alternative 3, although the level of lethal reduction used in Alternative 4 and the associated effects would be incrementally less because of the population-reducing effects of fertility control. The effects of research activities on wildlife and wildlife habitat would be the same as those described in Alternative 3.

The application of fertility control agents would depend on the effective duration of the control agent (i.e., single-year, multi-year, or lifetime) and whether the agent could be remotely delivered by dart or if the target elk would need to be captured and handled for treatment and possibly marking. If darting methods to administer the agent are available and effective, the effects on other wildlife would be associated with the presence of treatment teams in wildlife habitat and the short-term disturbance they would create. This would represent a short-term, local, negative effect on individuals of other wildlife species. If elk would need to be captured, the disturbance-related effects would last longer and likely be distributed over a larger area as elk would likely be more dispersed. The need to capture elk could be met using a capture facility such as a corral trap. Elk would be herded into the capture facility using trained herding dogs, riders on horseback, people on foot with noisemakers or visual devices (such as sticks with streamers), and helicopters as an adaptive tool if necessary. The impacts of these activities on individuals of other wildlife species would be negative. The effect of the capture facility on wildlife habitat would be short term and local, and the adverse effects would be up to minor, depending on the specific location and the habitat that would be affected.

The fertility control agents would have no effect on non-target species. One of the criteria for control agents states, "A fertility control agent must not have any adverse effects on non-target animals that consume elk meat. These would include no toxicity, no change in fertility, and no genetic mutations that would interfere with life cycles or be passed on to subsequent generations." In the case of Leuprolide, the active hormone would not pass into the food chain because it would cleave to constituent amino acids (Becker and Katz 1993). Any other fertility control agent considered for use would be required to meet this criterion as well. As a result, there would be no trophic pathway (i.e., food chain) effects on other wildlife species from the administration of fertility control agents to elk. The transport to waterways of the potential agents described in Chapter 2 is unknown at this time. If monitoring or new scientific information show that fertility control agents have affects on nontarget species, including fish, the use of the agent would be modified or stopped. Every effort would be made by staff to retrieve darts that have missed their target. Exposure of any special status species to a dart left in the field may have an effect on an individual but not would result in population-level effects.

The effects of lethal reduction activities redistribution activities, and installation and maintenance of fences on wildlife species and on biodiversity would be the same as described for Alternative 3.

Cumulative Impacts

Cumulative effects would be the same as described for Alternative 3.

Conclusion

Relative to Alternative 1 (future baseline condition), Alternative 4 would have the following effects on wildlife resources.

The effects of implementing Alternative 4 on wildlife would be similar to Alternative 3 on the primary winter range. On the primary summer range without the use of fences to protect montane riparian willow, small decreases in the intensity of the benefit would predominate. Areas on the primary winter range would see increased benefits for species that are reliant on or strongly associated with montane riparian willow habitat that would be fenced, where benefits would be long term, local, and minor to moderate as a result of the relatively rapid habitat restoration.

The administering of fertility control agents for population management and research purposes via darting methods would have negative effects on individuals of other wildlife populations in the vicinity of the activity. The use of a capture facility to treat a high number of elk would have short-term, adverse effects on wildlife habitat up to minor in intensity.

The cumulative effects of other plans, projects, and actions combined with the effects of Alternative 4 would continue to be long-term, moderate, and adverse.

Using the impairment analysis criteria presented in the beginning of this section, there would be no impairment of wildlife values or resources as a result of implementing Alternative 4.

The beneficial or adverse nature and the intensity of the effects for wildlife species as a result of Alternative 4 are summarized in Table 4.4.

TABLE 4.4: SUMMARY OF IMPACTS OF ALTERNATIVE 4 FOR WILDLIFE

Species/Group	Adverse or Beneficial Effect	Intensity of Effect
Larger wildlife	Adverse (fencing)	Minor
Species reliant on riparian willow	Beneficial	Minor to moderate
Biodiversity	Beneficial	Moderate
Mule deer	Adverse	Moderate to major
Moose	Adverse (aspen and willow fencing) Beneficial (habitat restoration)	Negligible to minor Minor
Bighorn sheep	Beneficial (habitat restoration)	Negligible
Mountain lion	Beneficial	Negligible
Red fox	Beneficial	Minor
Coyote	Adverse	Minor
Black bear	Beneficial	Negligible to minor
Bobcat	Beneficial	Negligible
Scavengers	Beneficial	Minor
Small mammals	Beneficial	Minor
Beaver	Beneficial	Moderate
Ptarmigan	Beneficial	Minor to moderate

TABLE 4.4: SUMMARY OF IMPACTS OF ALTERNATIVE 4 FOR WILDLIFE (CONTINUED)

Species/Group	Adverse or Beneficial Effect	Intensity of Effect
Songbirds	Beneficial	Moderate to major
Cavity nesting birds	Beneficial	Moderate to major
Raptors	Beneficial	Minor to moderate
Waterfowl and shorebirds	Beneficial	Minor to moderate
Upland shrub birds	Adverse (increased deer in long-term) Beneficial	Moderate Minor
Fish	Beneficial	Minor
Amphibians and reptiles	Beneficial	Minor to moderate
Butterflies	Beneficial	Minor to moderate

Alternative 5

This alternative would involve releasing a small population of gray wolves in Rocky Mountain National Park in a phased approach, in combination with lethal control of elk, to achieve an elk population that would fluctuate within the natural range of variation of 1,200 to 2,100 elk. Wolves would be established in the park in very small numbers in the early phase of the plan and gradually be allowed to increase in later phases if it is determined that the wolves can be effectively managed and that plan management objectives are being met. Wolves would be monitored and their movements and activities restricted to the park. As wolf predation of elk in the park would increase, and based on monitoring of the elk population, the intensity of lethal reductions by NPS staff and their authorized agents would be modified to meet elk population objectives. It is assumed that wolves would effectively redistribute the elk population; therefore, no other redistribution techniques or fencing of montane riparian willow habitat would be required to support vegetation protection and restoration. Aspen would be fenced as in all action alternatives (up to 160 acres). A research study would be undertaken in the first three years of the plan to evaluate procedures for testing live elk for chronic wasting disease in free-ranging elk.

General Effects of Alternative 5 on Wildlife

The presence of wolves would benefit wildlife habitat as a result of trophic cascade effects. The trophic cascade concept addresses the effects that a top-level carnivore, the wolf, has on herbivore populations and their behavior, which in turn affects vegetation communities, which support various wildlife populations and ecological processes (Wilmers et al. 2003, Hebblewhite et al. 2005). Wildlife habitats would experience ecosystem-level beneficial effects as a result of the carnivore-herbivore interactions and how those interactions affect montane riparian functions, beaver populations (a keystone species), and vegetative communities (Ripple et al. 2001, Ripple and Beschta 2003, Ripple and Beschta 2004b). Dispersion of high concentrations of browsing ungulates by wolves would have a cascading effect that would benefit montane riparian willow, aspen (Fortin et al. 2005), and meadow grassland habitats in the core winter elk range. This benefit would improve habitat resources for some wildlife species and would represent a long-term, range-wide, moderate-to-major beneficial effect for wildlife species dependent on willow and aspen areas and commensal species (species that benefit from the activities of another species with no harm or return affect).

Lethal reduction of the elk population would have similar effects as a result of reduced foraging pressure. The effects would be long term, moderate, park wide, and beneficial. The effects of lethal reduction activities (i.e., crews traveling through wildlife habitat, removing carcasses) on wildlife would be adverse and similar to the effects described for Alternative 3, although as the wolf population became established over time, the need for elk population reduction would lessen, as would the impacts of reduction activities.

Fencing in aspen communities would have effects on wildlife habitat and wildlife species similar to those described for Alternative 2. No other fencing or redistribution techniques would occur because these elements would not be needed under this alternative; wolves would provide the redistribution and disperse high concentrations of ungulates in montane riparian habitats.

Wildlife would be affected by helicopter overflights that would transport fence material into the park. This disturbance would represent a short-term, negative effect on wildlife.

The effects on biodiversity would be similar to those described for Alternative 2, although incrementally greater as a result of the release of an extirpated species, the gray wolf.

The effects associated with research activities evaluating procedures to test for chronic wasting disease in live elk would be similar to Alternative 2.

Ungulates

The effects associated with the release of wolves would be relatively small during the first phase of the alternative because only four wolves would be present in the park. Other elements of the alternative's management actions (i.e., lethal reduction and redistribution actions, if necessary) would compensate for the small contribution of wolves in the initial stages of Alternative 5. Over time, assuming successful wolf management, the wolves would be allowed to reproduce and the effects identified below would be more fully realized as a result of greater reliance on wolves and less reliance on other management tools.

Wolves would potentially prey on deer and moose, although it is expected that elk would be the primary wolf prey. Predation would increase stress levels and energy use by ungulates, although in the long-term, this would represent a return to natural conditions, with the return of a top trophic-level predator reestablishing a natural population regulation mechanism for ungulates. In the long-term, natural selection forces (e.g., wolves preying selectively on young, aged, weakened, or otherwise susceptible animals) would improve the overall fitness of ungulate populations as those animals better able to escape predators would have a higher likelihood of surviving and passing on learned behavior or genetic traits. Although the release of the wolf would have negative effects on individuals, the effect on ungulate populations would ultimately be a benefit, as an integral element of the ecosystem was restored. This would represent a long-term, minor, park-wide benefit to ungulates. With deer and elk in particular, there could be reduced intraspecific competition and the risk of chronic wasting disease transmission could be lowered, a long-term, regional, minor benefit.

The effect on bighorn sheep as a result of the presence of wolves would be similar to that discussed above for deer and moose with an improvement in overall fitness and a benefit as a result of a return to natural conditions. However, bighorn sheep numbers from the Mummy Range population have declined in recent years below what would be expected under natural conditions due to a variety of other issues. Wolves could potentially kill bighorn sheep from this herd during the summer months when the sheep come down to Horseshoe Park and when wolves would be denning in these low elevation areas. Bighorn sheep could experience a local, long-

term, moderate, adverse effect. During the winter, bighorn are generally up high or outside the park, when wolves would be on the primary winter range.

Predators and Scavengers

Wolves compete with and often kill coyotes (Crabtree and Sheldon 1999). Coyote population numbers would decrease as a result of the direct competition with wolves, which would represent a minor, long-term, park-wide benefit because this would be representative of more natural conditions. Foxes would benefit as a result of a reduced coyote population because foxes compete more closely with coyotes (Smith et al. 2003). The beneficial effect would be long term and minor.

Black bears may be adversely affected due to competition with wolves for forage. Wolves may compete with black bears for forage but this would represent a return to natural conditions. Black bears would benefit from scavenging the carcasses of elk left by wolves as documented to occur in Yellowstone National Park (Smith et al. 2003). There could be a long-term, negligible to minor benefit to black bears as a result of increased availability of carcasses.

Mountain lions and wolves both rely on ungulates as a primary food source. There has been little documented about the interaction of wolves and mountain lions, likely due to the separation of habitat use by the two species, as cougars use rocky outcrops and cliffs. Research in Yellowstone National Park suggest that mountain lions avoid wolves, are subordinate at kill sites, and are at risk of predation by wolves (Smith 2005). These interactions represent a natural condition and are beneficial. An increase in deer and small mammals would benefit mountain lions. The overall effect on mountain lions would be negligible beneficial. Other scavengers would benefit from wolf-kill carrion because wolves often only partially consume their prey (Wilmers et al. 2003). The beneficial effect would not only be related to the biomass of available carrion, but the year-round availability would be an important factor that would benefit scavengers (Wilmers et al. 2003). Alternative 5 would represent a long-term, park-wide, minor-to-moderate benefit for scavengers.

Small Mammals

The restoration of montane riparian willow habitat as a result of direct elk population reduction activities, wolf predation pressure, and the dispersion of high concentrations of elk by wolves would enhance willow habitat and provide additional hiding, resting, and breeding cover for small mammals. The likely reduction in coyote populations as a result of competition with wolves would have a beneficial impact on small mammals, which coyotes primarily prey on. These effects would represent a long-term, park-wide, negligible -to-moderate benefit for small mammals. The range of benefits would be related to the relatively low influence of wolves in the early stages of the plan and would increase over time as the plan objectives were achieved.

Beaver

The combination of elk population reductions and wolf release would enhance the likelihood of successful beaver recovery because the competition between elk and beaver for forage would be reduced. These effects are similar to the effects attributed to Alternative 2. Although wolves would likely prey on individual beaver, which would partially offset the potential benefit for beaver, the predominant effect of wolves would more likely be a trophic cascade (Hebblewhite 2005, Smith 2005). With wolves present, elk may avoid some of the riparian areas on the primary elk range, reducing herbivory on woody vegetation such as willow and aspen that would

enhance the recruitment and structural diversity of these species in the riparian area and the availability of forage. The habitat changes would be the basis for the beneficial impact on beavers (Baker et al. 2005). Overall, the effect of Alternative 5 on beaver would be a long-term, park-wide, moderate benefit.

Birds

In general, the effects of wolf release and elk population reductions on avian populations would be similar to those described for Alternative 2. Some key differences would include incrementally greater benefits associated with trophic cascade factors related to wolves. Raptors would benefit as small mammals populations would become more diverse, and songbird populations may increase as riparian habitats would be restored (Smith 2005). The potential, moderate, adverse impacts on upland shrub birds as a result of increased deer populations, as described under Alternative 2, would be reduced to minor because wolves would redistribute elk and deer in all habitats, including upland shrubs, and would prey on deer.

Fencing around aspen would have the same effects on birds as described under Alternative 2.

Fish

The restoration of riparian willow habitats as a result of elk population reductions and the redistribution effects of wolves would enhance aquatic habitat conditions and, in turn, benefit fish populations. Trophic cascade factors (Smith 2005) would be responsible for the "trickle-down" of benefits. The benefits to fish would be long term, local, and minor to moderate, depending on the existing condition of a stream's riparian habitat.

Amphibians and Reptiles

The effects of Alternative 5 on amphibians and reptiles would be similar to those described for other wildlife as a result of the reduction in the elk population and the trophic cascade effects of wolf release. Habitat restoration, particularly in riparian willow and aquatic habitats, would be achieved as a result of the actions associated with this alternative, and the increase in area and quality of habitat would represent a long-term, local, minor-to-moderate benefit for amphibians and reptiles.

Cumulative Impacts

The existing effects of other plans, projects, and actions on wildlife would be the same as described for Alternative 1: short- and long-term, moderate, and adverse. Overall other wildlife populations are affected most predominantly by the habitat alterations that are creating adverse effects. Adverse effects of aerial overflights, forest management activities, small-scale construction projects in the park, and development outside of the park contribute somewhat to the overall moderate, adverse effects of habitat alteration. Management plans within the park are providing benefits to wildlife populations; however, these benefits are outweighed by the moderate, adverse cumulative effects discussed in Alternative 1 cumulative analysis.

Alternative 5's contribution to the overall cumulative impacts on wildlife would be similar to Alternative 2's, with minor to major, long-term benefits to wildlife. The release of wolves would create additional short-term and long-term, minor to moderate, adverse effects for some individual species of wildlife. The cumulative effects of other plans, projects, and actions,

combined with Alternative 5's contribution, would continue to be long-term, moderate, and adverse.

Conclusion

Relative to Alternative 1 (future baseline condition), Alternative 5 would have the following effects on wildlife resources.

In general, the effects of Alternative 5 are similar to those described for Alternative 2, with some important differences. Primarily, the effects related to a trophic cascade that would occur with the release of wolves would enhance ecosystem functions and benefit many wildlife species. Ranges of long-term benefits for a particular species or species group would be related to changing effects as this alternative progresses from the first phase, with a relatively large elk reduction component and small wolf population, to later phases, where the wolf population would be the primary component driving the effects. The benefits would range from negligible to moderate for small mammals; minor for ungulates; negligible to minor for other predators; minor to moderate for scavenger species, numerous avian species, fish, amphibians, and reptiles; moderate for beaver; and moderate to major for songbirds, cavity nesting birds, and wildlife habitat in general.

Characterization of adverse effects associated with Alternative 5 would be short-term and minor for all wildlife as a result of elk population reductions, although as the alternative progresses, the need for reduction actions by humans would diminish and the adverse effects would eventually decrease to negligible. The effects of wolf predation would be negative for individual ungulates, but ultimately, ungulate populations would benefit from a more complete ecosystem. Coyote would experience a decrease in population size, but this would be more reflective of natural conditions and would be a minor-to-moderate, beneficial effect as a result of competition with wolves. Minor adverse impacts on upland shrub birds would occur as deer populations would increase (although to a lesser degree than under Alternatives 2) and continue foraging pressure on upland shrub habitats.

Research activities evaluating procedures to test for chronic wasting disease in live elk would negatively affect individuals of wildlife species while activities were taking place but have no population-level effects. Use of a capture facility under this alternative for lethal reduction activities would have up-to-minor adverse effects on wildlife habitat. There would be no effect on other wildlife from fertility control agents administered by hand to elk subject to research actions.

The cumulative effects of other plans, projects, and actions, combined with Alternative 5's contribution, would continue to be long term, moderate, and adverse.

Using the impairment analysis criteria presented in the beginning of this section, there would be no impairment of wildlife values or resources as a result of implementing Alternative 5.

The beneficial or adverse nature and the intensity of the effects for wildlife species as a result of Alternative 5 are summarized in Table 4.5.

TABLE 4.5: SUMMARY OF IMPACTS OF ALTERNATIVE 5 FOR WILDLIFE

Species/Group	Adverse or Beneficial Effect	Intensity of Effect
Species reliant on riparian willow	Beneficial	Minor to moderate
Wildlife habitat in the elk primary winter range	Beneficial	Moderate to major
Biodiversity	Beneficial	Moderate to major
Mule deer	Beneficial	Minor
Moose	Adverse (aspen fencing) Beneficial (predation) Beneficial (habitat restoration and improved fitness)	Negligible Minor Minor
Bighorn sheep	Adverse (predation) Beneficial (habitat restoration)	Moderate Negligible
Mountain lion	Beneficial	Negligible
Coyote	Beneficial	Minor
Red fox	Beneficial	Minor
Black bear	Beneficial	Negligible to minor
Bobcat	Beneficial	Negligible
Scavengers	Beneficial	Minor
Small mammals	Beneficial	Negligible to moderate
Beaver	Beneficial	Moderate
Ptarmigan	Beneficial	Minor to moderate
Songbirds	Beneficial	Moderate to major
Cavity nesting birds	Beneficial	Moderate to major
Raptors	Beneficial	Minor to moderate
Waterfowl and shorebirds	Beneficial	Minor to moderate
Upland shrub birds	Adverse (increased deer) Beneficial (habitat improvement)	Minor Moderate
Fish	Beneficial	Minor to moderate
Amphibians and reptiles	Beneficial	Minor to moderate
Butterflies	Beneficial	Minor to moderate

WATER RESOURCES

Summary of Regulations and Policies

Federal Guidance

The objective of the Clean Water Act and amendments is to "restore and maintain the chemical, physical and biological integrity of the nation's waters." The overall goal of the Clean Water Act is to produce waters of the United States that are "fishable and swimmable." A primary means for evaluating and protecting water quality is the establishment and enforcement of water quality standards. Under the *Clean Water Act*, the federal government delegated responsibility for establishing water quality criteria to each state, subject to approval by the U.S. Environmental Protection Agency. Water quality standards consist of three parts: (1) designated beneficial uses of water (e.g., drinking, recreation, aquatic life); (2) numeric criteria for physical and chemical characteristics for each type of designated use; and (3) an "antidegradation" provision to protect uses and water quality.

In accordance with the Clean Water Act, states and territories define the uses for waters occurring within their borders, and each water body must be managed in accordance with its designated uses. Water quality standards are established for each designated use. Standards must be at least as stringent as those established by the U.S. Environmental Protection Agency, and in most cases, states have adopted the U.S. Environmental Protection Agency standards.

Under section 313 of the Clean Water Act, the National Park Service and all other federal agencies and departments must comply with all federal, state, interstate, and local requirements regarding the control and abatement of water pollution. This includes management of any activity that may result in the discharge or runoff of pollutants.

National Park Service Guidance

Section 4.6.3 of the *Management Policies* states that the National Park Service will "take all necessary actions to maintain or restore the quality of surface waters and ground waters within the parks consistent with the *Clean Water Act* and all other applicable federal, state, and local laws and regulations" (NPS 2006b). The service has also established general goals for water quality, and in accordance with these goals, works cooperatively with Colorado to protect and enhance the quality of water in Rocky Mountain National Park.

The National Park Service manages the waters in Rocky Mountain National Park in accordance with the Clean Water Act and Colorado water quality standards. Therefore, the service must meet state antidegradation provisions, which means the existing quality of state waters must not be degraded. This ensures that park waters can serve their intended purposes, as defined by the assigned beneficial uses.

State of Colorado Guidance

The Water Quality Control Commission of the Colorado Department of Public Health and Environment (CDPHE) released an amended water quality standards regulation in 2001. Regulation No. 31: The Basic Standards and Methodologies for Surface Water (5 CCR 1002-31) provides basic water quality standards, an antidegradation rule and implementation process, and a

system for classifying state surface waters, water quality standards, and granting temporary modifications and periodic reviews of the classification and standards.

According to the antidegradation rule, "the highest level of water quality protection applies to certain waters that constitute an outstanding state or national resource. These waters, which are those designated outstanding waters pursuant to section 31.8(2)(a), shall be maintained and protected at their existing quality." All waters in Rocky Mountain National Park are considered "Outstanding Waters" (CDPHE 2005). Beneficial use is the use of a reasonable amount of water necessary to accomplish the purpose of the appropriation, without waste (Colorado Division of Water Resources n.d.). Beneficial uses for the waters of Rocky Mountain National Park include aquatic life (Class 1: Cold Water Biota), recreation, water supply, and agriculture (CDPHE 2005).

Methodologies and Assumptions for Analyzing Impacts

Geographic Area Evaluated for Impacts

The geographic area evaluated for impacts on hydrology and water quality includes the primary winter and summer elk ranges, as these locations are the most affected by potential activities and are the primary habitats for elk in the park.

Streams and rivers within the elk primary winter range include Fall River, Big Thompson River, Roaring River, Beaver Brook, Mill Creek, Glacier Creek, and Hidden Valley Creek. The core winter range includes Moraine Park, Horseshoe Park, and Beaver Meadows, which include the streams of Beaver Brook, Cow Creek, Big Thompson River, and Fall River. Streams and within the elk primary summer range include the Colorado River, Cache la Poudre River, Big Thompson River, Chapin Creek, Onahu Creek, Tonahutu Creek, Fall River, and Willow Creek.

Cumulative effects that would occur both inside and outside these areas were evaluated using the methods described in the "Cumulative Analysis" section.

Issues

Issues that were raised during internal and public scoping regarding elk and vegetation management activity effects on soils included runoff effects on water quality, water quality as related to high wildlife density (e.g., bacteria, ammonia, nitrates, fecal matter) and alteration of hydrology from beaver reintroduction.

The public also identified a need to address restoration of an intact ecosystem in addition to focusing on elk and vegetation.

Assumptions

For the purposes of this evaluation, it was assumed that a reduced beaver population would contribute to changes in hydrology (e.g., lowered water table, reduced ponding, higher velocity of flows).

Potential effects of elk on water quality and hydrology were also assumed to occur predominantly in the elk core winter range, because that is where elk densities are high and also where the majority of surface waters associated with willow occur. It is assumed for analysis purposes that effects of elk use on the primary winter range are also occurring in the Kawuneeche Valley; however, the intensity of effects would be smaller because in the Kawuneeche Valley elk densities are lower, and forage availability is higher during the summer growing season.

Assessment Methods

Primary steps for assessing impacts included identifying 1) the location of surface water in areas likely to be affected by the proposed alternatives and 2) potential changes in surface water and hydrology from current and future elk and vegetation management actions.

To understand the effects of elk and vegetation management methods on the hydrology and water quality in specific areas of concern, park resource inventories and management plans, scientific literature, and published technical data were consulted to identify the information contained in this analysis. Primary data sources included Peinetti et al. 2001, Baker et al. 2005, and NPS 2001. Research of elk herbivory, a high elk population level, and beaver reduction's effects on hydrology and water quality has occurred in the elk core winter range (i.e., Moraine Park, Horseshoe Park and Kawuneeche Valley). In other streams research was not available (i.e., in the primary summer range), but effects were assumed to be similar.

Analysis of effects of elk herbivory and reduction in beavers on hydrology relied heavily on aerial photography and digital imagery that compared changes in stream length and sinuosity over time in Moraine and Horseshoe Parks, partially as a result of a reduced beaver population (Peinetti et al. 2002). Research about the relationship between hydrology and vegetation is discussed in the "Vegetation" section.

The analysis of the changes in hydrology, stream function, or water quality condition under Alternative 1 was based on the existing condition of surface waters and groundwater on the elk range and the change in this condition over time.

The data from the baseline water quality data inventory and analysis indicated that surface waters within the park were generally of good quality but had some localized impact from natural and human activities. However, because effects from wildlife and other natural sources of nutrients have not exceeded water quality standards within the park, the use of water quality standards is a threshold too coarse for this evaluation; therefore, the impact thresholds below do not include specific mention of Water Resources Division or State of Colorado Water Quality Standards.

Under all action alternatives, a research study would be conducted in coordination with elk and vegetation management activities. The study would be conducted over a three-year period and would involve approximately 120 elk. During this study, the National Park Service would evaluate procedures to test for chronic wasting disease in live elk and the effectiveness of a fertility control agent and would involve the capture or darting, anesthetizing, and handling of elk within the framework of an alternative. It is expected that research activities would not have any effect on water quality and hydrology due to the short time period involved, the type of activities would not appreciably disturb vegetation or soils, and actions would not be conducted in aquatic habitats. The study would treat approximately half of the female elk captured with a fertility control agent. Concerns have been raised about whether excreted elk waste from elk treated with fertility control agents could contain harmful products that could be transported into the water and affect water quality. Due to the low number of female elk treated for this study over a short-period, no effect on water quality is expected as a result of fertility control agents used in this study.

Impact Threshold Definitions

Impacts were evaluated using the following thresholds.

Intensity of Impacts

Hydrology and Stream Structure

Negligible: Hydrology or stream structure would not be affected or the effect would be below or at levels of detection. Changes to sinuosity, bank stability, groundwater levels, or flow velocity would not be detectable.

Minor: The effects on hydrology or stream structure would be detectable, but effects on sinuosity, bank stability, groundwater levels, or flow velocity would be small.

Moderate: The effect on the sinuosity, bank stability, groundwater levels, or flow velocity would be readily apparent and would result in a notable change in stream function or hydrology of the area.

Major: The sinuosity, bank stability, groundwater levels, or flow velocity would greatly change and would substantially alter stream function or hydrology of the area.

Water Quality

Negligible: Chemical, physical, or biological changes to water quality would not be detectable, and effects would be well within natural or desired water quality conditions and would not contribute to degradation.

Minor: Chemical, physical, or biological changes to water quality would be detectable but would not contribute to degradation, and would be within natural or desired water quality conditions.

Moderate: Chemical, physical, or biological changes to water quality would be detectable but would not result in degradation. Water quality would be altered compared to natural baseline or desired water quality conditions.

Major: Chemical, physical, or biological changes to stream water quality would be readily measurable and would be frequently altered from the natural baseline or desired water quality conditions.

Type and Duration of Impact

Beneficial impact would contribute to the restoration of natural hydrologic conditions (e.g., increase surface area of water and water table levels, stabilize riverbanks), improve water quality (e.g., reduce sedimentation, bacteria levels), or improve or maintain aquatic habitat.

Adverse impact would contribute to the alteration of natural hydrologic conditions (e.g., reduce surface area of water and water table levels, cause unnatural erosion or deposition), degrade water quality (e.g., increase sedimentation, temperature, or bacteria levels), or degrade aquatic habitat.

Duration: Short-term impacts would allow recovery in less than one year. Long-term impacts would require one year or more for recovery.

Impairment

An impairment of water resources would occur when actions contribute substantially to deterioration of stream structure, hydrology, and/or water quality to the extent that the surface waters throughout the park would no longer function as natural systems. The impacts would involve deterioration of the park's water quality and hydrology to the point that park purposes could not be fulfilled, or resources could not be experienced and enjoyed by future generations

Alternative 1

Hydrology and Stream Structure

Historically, beaver have had a large influence on hydrology and stream structure within low-gradient streams in Rocky Mountain National Park. Beaver activities include creating dams and canals, which increase river complexity by slowing water current velocity, elevating the groundwater level, equalizing the water discharge rate by retaining runoff during high flows and slowly releasing it, altering waterway gradients by creating a stair-step profile, and increasing resistance to disturbance within the waterway (Gurnell 1998, Naiman et al. 1988, Baker et al. 2005). While trapping practically removed beaver from Estes Valley, beaver were still abundant in the park in 1915, when the park was first established (Zeigenfuss et al. 2002 and Baker et. al 2005). However, beaver have since declined in the eastern portions of the park. For example, beaver have declined from 315 in 1939 to 12 in 1994-1998 on the Big Thompson River, located in the core elk range (Zeigenfuss et al. 2002 and Baker et. al 2005).

These declines in beaver correlate with changes in hydrology and vegetation. In a comparison of 1937 and 1996 aerial photographs, Peinetti et al. (2002) found a reduction in sinuosity and in total surface water in Moraine Park and Horseshoe Park. In Moraine Park, stream lengths (and, therefore, sinuosity) were reduced by 56%; in Horseshoe Park, that number was 44%. Total surface water also decreased, by 69% and 44% for Moraine and Horseshoe Parks, respectively. Well-defined beaver dams were detected in the 1937 aerial photos, especially at the upgradient entrances to the meadows, which play a large role in the stream structure in the meadows below, but the majority of the beaver dams had disappeared by 1996.

Based on research of willow, elk, and beaver interactions in Rocky Mountain National Park, Baker et al. (2005) concluded that the mutual relationship between beaver and willow collapses in the face of heavy browsing by elk. In riparian systems where elk are abundant, they will outcompete and exclude beaver. These conditions would continue under Alternative 1. Thus, the changes in hydrology observed on the core winter range in the park are likely to continue as a result of the high densities of elk that browse in these areas and the correlated reduction or suppression of the beaver population.

Continued high densities and numbers of elk on the core winter range under Alternative 1 would continue to outcompete beaver, preventing vegetation recovery necessary for beaver to recolonize (see "Vegetation" section for a discussion on elk herbivory). Thus, hydrological conditions would remain changed from recent natural conditions (e.g., straighter streams, lower water tables), representing a long-term, major, adverse effect on hydrology in the core winter range. While data on beaver populations and hydrological changes in the Kawuneeche Valley are limited to personal observations, elk, willow, and beaver are interacting in the same manner, although to a lesser degree because of reduced elk densities and increased forage. Therefore, hydrological conditions would also be adversely affected in the Kawuneeche Valley elk range, but less so, resulting in long-term, moderate effects. This would be expected to progress to major later in the plan as the effect of elk on beaver increases.

Runoff Effects on Water Quality

As described in the "Soils" section, erosion and, therefore, sediment entering streams under Alternative 1 would be long term, local, minor, and adverse in the elk core winter range and Kawuneeche Valley and negligible in other areas of the elk range. Sediment entering streams due to bank destabilization resulting from high elk densities in the core winter range would be negligible and adverse.

Based on visual observations in Rocky Mountain and Yellowstone National Parks (see "Soils and Nutrient Cycling" for details), it is likely that increases in turbidity from destabilization of banks by elk is minimal. The baseline water quality data inventory and analysis did not identify turbidity as exceeding water quality standards anywhere within the park (NPS 2001b). Because this is total turbidity, including effects of geologic erosion, erosion by other wildlife, and by human use of the park, it is unlikely that the elk population contributes much to erosion. Effects on water resources would therefore be long term, negligible to minor, and adverse in the core winter range, where elk densities are high. For other portions of the winter and summer elk range, effects would be negligible.

Water Temperature

Elk would continue to degrade willow under Alternative 1, and already degraded willow would be unable to recover in the presence of the same elk population level and herbivory levels (see "Vegetation" section for further explanation). These changes in the montane riparian community, such as decreases in tall willow along streams, would continue to result in reduced shading of streams, as vegetative cover of surface waters has been reduced, although no water quality measurements in the park have exceeded standards for temperature. This effect on water temperature would represent a long-term, local, minor, adverse effect on water resources on the elk core winter range and Kawuneeche Valley, because it has likely altered stream temperature from recent natural conditions. Because data on temperature for the streams in the core elk primary winter range are limited, it is unknown what the level of change from natural conditions has been. However, high elevation streams in areas with a short summer season, such as on the core winter range, typically have water temperatures that would remain cold through the summer. Because natural conditions had stream shading, it can be assumed that the ideal conditions for aquatic communities in these stream reaches would be the temperature that occurs with stream shading. Therefore, the reduction in stream shading as willow has been replaced with grasses along montane riparian areas in the core elk winter range and Kawuneeche Valley would cause minimal effects that would be difficult to detect among other confounding factors such as climate change. Therefore, effects would be long term, local, negligible, and adverse for water resources in the core winter range and in the primary summer range.

Contaminants

Contributions from ungulate waste can be an important source of contamination to surface waters. In Virginia, multiple streams' total maximum daily loads for fecal coliform were exceeded by wildlife (primarily deer) alone (Mostaghimi et al. 2002). However, the baseline water quality data inventory and analysis by the NPS Water Resources Division described in "Affected Environment" did not identify wildlife as a primary source of contamination (NPS 2001b). Aside from fecal coliform, no other water quality parameters potentially related to wildlife were exceeded within the park. Fecal coliform only exceeded standards near developed areas in the park, which is likely due to human waste rather than wildlife excreta. Based on this information, the current elk population may introduce bacteria, ammonia, nitrates, and fecal matter to surface

waters, but only at an undetectable level. Therefore, effects on water quality from continuing current management of elk and vegetation would be long term, negligible, and adverse.

Cumulative Impacts

Hydrology and Stream Structure

Hydrology and stream structure would be affected by a restoration project that includes installation of Fan Lake fencing, which would eliminate elk use in a small area, thereby allowing conditions conducive to beaver to return and alter the hydrology of the area, a long-term, local, negligible-to-minor, beneficial effect on water resources.

Alternative 1 would have a long-term, major, adverse impact from the reduced effect of beaver on hydrology and stream structure. The Fan Lake project would not have an appreciable impact on the cumulative environment and cumulative impacts would be long term, major, and adverse.

Water Quality

Nitrogen deposition occurring as a result of agricultural fertilizers and combustion in vehicles and factories has been altering and will continue to alter surface waters in Rocky Mountain National Park. The introduction of additional nitrogen to nitrogen-limited systems can affect water's natural buffering abilities and contribute to acidification. Also, the addition of nitrogen to surface waters is an adverse effect on water quality. Nitrogen deposition is having a long-term, moderate-to-major, adverse effect on water quality throughout the park, especially in high-elevation areas.

Prescribed burns that are conducted could affect water quality, although the effect would only be negligible, because of mitigation measures that are implemented. Fencing of willows at Lawn Lake would reduce erosion, thereby reducing turbidity of streams, a negligible, beneficial effect. Herbicides used for exotic plant removal and insecticides could potentially affect water quality, although with mitigation measures, the resulting adverse effect would be short term, local, and minor (NPS 2003c). However, piscicides that could potentially be used instream for removing fish would have short term, local, moderate, adverse effects, as they would affect the water quality of a particular stream reach in a very detectable manner.

Effects from other plans and projects on water quality would be long term, moderate, and adverse. Alternative 1 would make a long-term, negligible-to-minor, adverse contribution, resulting in overall cumulative effects that would be long term, moderate, and adverse.

Conclusion

Hydrological changes as a result of a reduced beaver population in the park would continue to represent a long-term, local, major, adverse effect on hydrology and stream structure in the winter elk range. Effects would be moderate, but progress to major later in the plan in the summer elk range. Sediment entering streams from erosion of bare ground would be long term, local, minor, and adverse in the winter elk range and Kawuneeche Valley, but negligible in other areas of the primary summer range, due to lower densities of elk. Bank destabilization from the degradation of willows by elk would cause a slight increase in turbidity, resulting in long-term, local, negligible to minor, adverse effects on water quality in the core winter range and Kawuneeche Valley and negligible adverse effects on water quality in the remainder of the winter and summer elk range. Slight increases in water temperature during the summer months as a result of elk

herbivory of willow would represent a long-term, local, negligible, adverse effect on water quality. Effects on water quality from elk introducing bacteria, ammonia, nitrates, and fecal matter to surface waters would be long term, negligible, and adverse.

Cumulative effects on hydrology would be long term, major, and adverse, with Alternative 1 contributing long-term, major, adverse effects. Cumulative effects on water quality would be long term, moderate, and adverse, with Alternative 1 making a long-term, negligible to minor, adverse contribution.

Impairment of water resources within the park would not occur under Alternative 1.

Alternative 2

Hydrology

A large reduction in the elk population would reduce the total number of elk that would occur on the core winter range. Redistribution effects would help to ensure that these elk do not continue to congregate in high densities. The combination of these activities would increase willow size and cover, which would allow beaver to recolonize on the core winter range and in the Kawuneeche Valley. The recolonization or reintroduction of beaver would, in the long term, raise groundwater elevations, increase stream sinuosity, and, overall, increase the quantity of surface water, as described by Naiman et al. (1988). Willow and aspen will not be fully recovered within the 20-year time frame of the plan, so only partial beaver recovery would be supported. Thus, the resultant long-term change in hydrology from the actions of Alternative 2 would represent a moderate, beneficial effect on waters on the core winter elk range and possibly Kawuneeche Valley, if willow conditions improve, and a minor, beneficial effect in other portions of the primary winter range and the primary summer range.

Runoff Effects on Water Quality

Under Alternative 2, the maximum reduction of elk would result in an increase in willow cover over time because of reduced elk herbivory, willow replantings, and prescribed burns and mechanical methods for stimulating new plant growth. Decreases in erosion as a result of increased willow cover and the subsequent soil retention would decrease turbidity. However, because exclosure data show only a 4.6% difference in areas completely excluded from elk and areas with current levels of elk (Singer et al. 2002), it is likely that a 50% decrease in the elk population would have little effect on and would represent a long-term, local, negligible, beneficial impact on water quality.

Potential short-term impacts associated with lethal control and vegetation management activities (e.g., vehicle use near waterways, removing carcasses through water, prescribed burns, mechanical thinning) would be minimized or avoided by restricting control activities that could potentially affect water quality to the extent possible. The effects, considering mitigation measures, would be short term, local, negligible to minor, and adverse.

Mechanical thinning would be unlikely to affect water quality because removal of aboveground vegetation would not remove litter or disturb the soil, which could increase chances of erosion. Vehicle use near waterways would not affect water quality or hydrology because banks and the stream would remain undisturbed. Removing carcasses through water could potentially affect banks and add contaminants to streams, but because this would occur on a limited basis, adverse effects on water resources would be local and negligible to minor.

Prescribed burns can alter stream chemistry by releasing calcium and increased soil pH, but effects in the Sierra Nevada have been shown to last only three months for more extensive burns than what would likely occur under this alternative (Stephens et al. 2004). This would indicate that the effects of prescribed burns on water resources, small burns conducted in montane riparian areas and aspen stands would have limited effects on turbidity and changes in stream chemistry. Therefore, the short-term, adverse effects would be local and negligible to minor.

Water Temperature

Changes in the montane riparian community (i.e., increased willow growth and cover along and over aquatic habitats) would result in decreased water temperatures as a result of shading by vegetative cover. Because the natural range of variation in the core winter elk range included more extensive willow vegetation than occurs now, this return to more stream shading would be beneficial. Beneficial effects would be negligible along stream reaches in the core winter range.

Contaminants

Reduced elk population levels would reduce introduction of bacteria, ammonia, nitrates, and fecal matter by elk to park surface waters. However, this effect would be slight and likely undetectable, resulting in a local, negligible, beneficial effect. Prescribed burns could potentially introduce contaminants into surface waters, but only for the short term and in limited amounts (Stephens et al. 2004; Elliott and Vose 2005), resulting in local, minor, adverse effects.

Cumulative Impacts

Hydrology and Stream Structure

Effects of other plans, projects, and actions on hydrology and stream structure would be the same as described for Alternative 1: long term, negligible to minor, and beneficial. Alternative 2's contribution to cumulative effects would be long term, moderate, and beneficial. Cumulative effects would be long term, minor to moderate, and beneficial.

Water Quality

Effects on water quality from other plans, projects, and actions would be the same as for Alternative 1: long term, negligible to minor, and adverse. Alternative 2 would contribute long-term, negligible-to-minor, beneficial effects, overall resulting in no cumulative effect.

Conclusion

Recolonization or reintroduction of beaver would cause long term, local, moderate, beneficial effects on hydrology by altering the hydrology of streams in the elk core winter range and possibly Kawuneeche Valley, if willow conditions improve, and minor benefits in other portions of the primary winter range and the primary summer range. An increase in willow cover over time would decrease erosion and, therefore, turbidity, resulting in a long-term, local, negligible, beneficial impact on water quality. Short-term adverse impacts from lethal control and vegetation management activities would be local and negligible to minor with mitigation measures in place. Increases in willow cover would also increase stream shading, a long-term, local, negligible, beneficial effect on water temperature throughout the elk primary winter and summer ranges. Reduced elk populations would result in slightly less contamination from the introduction of

bacteria, ammonia, nitrates, and fecal matter by elk to surface waters in the elk range, a local, negligible, beneficial effect; but prescribed burns could potentially alter stream chemistry in the short term, a local, minor, adverse effect.

Cumulative effects on hydrology and stream structure would be long term, minor to moderate, and beneficial, with Alternative 2 contributing long-term, moderate, beneficial effects. On balance, there would be no cumulative effects on water quality, although Alternative 2 would contribute long-term, negligible-to-minor, beneficial effects that would offset adverse effects of other projects and plans.

Impairment of water resources within the park would not occur under Alternative 2.

Alternative 3

Hydrology

Reduction in elk population and fencing of montane riparian willow on the primary elk range would facilitate recovery of the montane riparian willow. Fenced areas would impart long-term, local, moderate benefits to stream structure in areas of the primary summer and winter ranges as montane riparian vegetation would recover and beaver would likely recolonize the areas where habitat is appropriate. However, in unfenced areas elk grazing would continue and, as a result, there would be less potential than fenced areas for beaver recovery and resultant improvements in stream structure. Because elk numbers would be reduced to upper levels of the natural range of variation, the improvement of unfenced stream reaches would be long term, local, minor, and beneficial. Long-term benefits to hydrology would be moderate in areas of the primary elk range where willows are fenced.

Runoff Effects on Water Quality

As stated in Alternative 2, because exclosure data show only a 4.6% difference in areas completely excluded from elk and areas with current levels of elk (Singer et al. 2002), a reduction in the elk population would not have much effect on bare ground and erosion. This decrease would represent a long-term, local, negligible, beneficial impact on water quality. For areas that are fenced from elk, bare ground would be expected to be reduced similar to the exclosure data (4.6%). However, because slopes are relatively flat in areas of the primary summer and winter range where fences would be installed, it is unlikely that this minimal decrease in bare ground would result in detectable differences in turbidity. Therefore, beneficial effects on water quality from reduction in sediments transported to streams from a reduction in bare ground would be negligible.

Potential short-term impacts associated with lethal control and vegetation management activities (e.g., vehicle use near waterways, removing carcasses through water, prescribed burns, mechanical thinning) would be the same as those described for Alternative 2.

Water Temperature

Effects on water temperature would be the same as those described for Alternative 2.

Contaminants

Effects on water quality through a slight reduction in contaminants entering surface waters and potential contaminants from prescribed burns would be the same as those described for Alternative 2, but would occur potentially sooner.

Cumulative Impacts

Hydrology and Stream Structure

Effects of other plans, projects, and actions on hydrology and stream structure would be the same as those described for Alternative 1: long term, negligible to minor, beneficial. Alternative 3's contribution to cumulative effects would be long term, minor to moderate, and beneficial. Cumulative effects would be long term, minor to moderate, and beneficial.

Water Quality

Effects on water quality from other plans, projects, and actions would be the same as those described for Alternative 1: long term, negligible to minor, and adverse. Alternative 3 would contribute long-term, negligible, beneficial effects, resulting in a cumulative effect that would be long term, negligible, and adverse.

Conclusion

Recolonization or reintroduction of beavers would result in overall effects on hydrology similar to those described for Alternative 2: long term, local, moderate, and beneficial, although changes in hydrology would vary between fenced and unfenced areas. An increase in willow cover over time would decrease erosion and, therefore, turbidity, resulting in a long-term, local, negligible, beneficial effect on water quality. Short-term impacts from lethal control and vegetation management activities would be the same as those described for Alternative 2: local, negligible to minor, and adverse. Increases in willow cover would also increase stream shading similar to Alternative 2, although effects would vary slightly between fenced and unfenced areas: long term, local, negligible, and beneficial. Reduced elk populations would result in slightly fewer contaminants from elk entering surface waters in the elk range, a local, negligible, beneficial effect; but prescribed burns could potentially introduce contaminants (e.g., excessive nutrients) in the short term, representing a local, minor, adverse effect.

Cumulative effects on hydrology and stream structure would be long term, minor to moderate, and beneficial, with Alternative 3 contributing long-term, minor to moderate, beneficial effects. Cumulative effects on water quality would be negligible and adverse, with Alternative 3 contributing long-term, negligible, beneficial effects.

Impairment of water resources within the park would not occur under Alternative 3.

Alternative 4

Hydrology

The recolonization or reintroduction of beaver would have the same beneficial effects as those described for Alternative 3 in fenced areas of aspen and montane willow (long-term moderate

benefits). In the primary summer range where montane riparian willow would not be fenced, the benefits would be minor.

Runoff Effects on Water Quality

The negligible, beneficial effects on water quality would be the same as those described for Alternative 3.

Water Temperature

The negligible, beneficial effects on water quality would be the same as those described for Alternative 3.

Contaminants

Effects on water quality through a slight reduction in contaminants entering surface waters and potential contaminants from prescribed burns would be the same as those described for Alternative 2.

Concerns have been raised about whether excreted elk waste from elk treated with fertility control agents could contain harmful products that could be transported into the water and affect water quality. The transport to waterways of the potential agents described in Chapter 2 is unknown at this time. Nonsteroidal hormones (including GonaCon™ and Leuprolide), once administered to the animal, are metabolized into basic amino acids and, therefore, would not likely pass through the food chain or present a hazard to water quality via elk urine (Becker and Katz 1993). If based on monitoring or new scientific information it is determined that fertility control agents are found to have affects on water quality or nontarget species the use of the agent would be modified or stopped.

Cumulative Impacts

Cumulative effects would be the same as those described for Alternative 3.

Conclusion

Recolonization or reintroduction of beavers would result in overall effects on hydrology similar to those described for Alternative 3: long term, local, moderate, and beneficial in the core winter elk range, but minor and beneficial in the primary summer range, although changes in hydrology would vary between fenced and unfenced areas. An increase in willow cover over time would decrease erosion and, therefore, turbidity, resulting in a long-term, local, negligible, beneficial effect on water quality. Short-term impacts from lethal control and vegetation management activities would be the same as those described for Alternative 2: local, negligible to minor, adverse. Increases in willow cover would also increase stream shading similar to Alternative 2, although effects would slightly vary between fenced and unfenced areas: long term, local, negligible, and beneficial. Reduced elk populations would result in slightly less contaminants from elk entering surface waters in the elk range, a local, negligible, beneficial effect; but prescribed burns could potentially introduce contaminants (e.g., excessive nutrients) in the short term, a local, minor, adverse effect. No effect on water quality would occur from the use of fertility control agents.

Cumulative effects on hydrology and stream structure would be long term, minor to moderate, and beneficial, with Alternative 4 contributing long-term, minor, beneficial effects. Cumulative effects on water quality would be negligible and adverse, with Alternative 4 contributing long-term, negligible, beneficial effects.

Impairment of water resources within the park would not occur under Alternative 4.

Alternative 5

Hydrology

The recolonization or reintroduction of beaver would have the same beneficial effects as those described for Alternative 2.

Runoff Effects on Water Quality

The negligible, beneficial effects on water quality would be the same as those described for Alternative 2.

Water Temperature

Water quality changes in the montane riparian community would result in the same effects as those described for Alternative 2.

Contaminants

Effects on water quality, as a result of a slight reduction in contaminants entering surface waters and potential contaminants from prescribed burns, would be the same as those described for Alternative 2. The number of wolves under Alternative 3 would be limited and would therefore have no effect on water quality from fecal matter.

Cumulative Impacts

Cumulative effects would be the same as those described for Alternative 2.

Conclusion

Recolonization or reintroduction of beavers would result in overall effects on hydrology similar to Alternative 2: long term, local, moderate, and beneficial in the elk core winter range, but minor and beneficial in the primary summer range. An increase in willow cover over time would decrease erosion and, therefore, turbidity, resulting in a long-term, local, negligible, beneficial effect on water quality. Short-term impacts from lethal control and vegetation management activities would be the same as Alternative 2: local, negligible to minor, and adverse. Increases in willow cover would also increase stream shading similar to Alternative 2, although effects would vary slightly between fenced and unfenced areas: long term, local, negligible, and beneficial. Reduced elk populations would result in slightly less contamination from elk entering surface waters in the elk range, a local, negligible, beneficial effect, but prescribed burns could potentially introduce contaminants (e.g., excessive nutrients) in the short term, a local, minor, adverse effect. The release of wolves would have no effect on water quality.

Cumulative effects on hydrology and stream structure would be long term, minor to moderate, and beneficial, with Alternative 5 contributing long-term, moderate, beneficial effects. Cumulative effects on water quality would result in no effect, with Alternative 5 contributing long-term, negligible-to-minor, beneficial effects.

Impairment of water resources within the park would not occur under Alternative 5.

SOILS

Soil depth, texture, and fertility are important components of a productive natural system and indirectly determine the type of vegetation that an area can support and the productivity of the wildlife populations dependent on those plant resources.

Summary of Regulations and Policies

The fundamental mission of the national park system is to conserve park natural and historic resources and to provide for the enjoyment of park resources only to the extent that the resources will be left unimpaired for the enjoyment of future generations. Current laws and policies require that soils in national park units function as naturally as possible as specified in *Management Policies*. The National Park Service will "seek to prevent the unnatural erosion, physical removal, or contamination of the soil, or its contamination of other resource" (NPS 2006b). Management goals for soils are included in section 4.8.2.4 of *Management Policies*. Management actions will be taken to prevent or minimize adverse, potentially irreversible impacts on soils. The park's general management plan and resource management plans support preserving the natural character of resources, including soils. Soil resources should be monitored regularly and mitigation provided.

Methodologies and Assumptions for Analyzing Impacts

Geographic Area Evaluated for Impacts

The geographic area evaluated for impacts on soils and nutrient cycling includes the primary elk primary winter and summer ranges, as these locations are the most affected by potential activities and are the primary habitats for elk in the park. The soils analysis focuses on those portions of the elk range, particularly the core winter range, where elk concentrations have the potential to affect soils far more than elsewhere in the range. Cumulative effects that would occur both inside and outside these areas were evaluated using the methods described in the "Cumulative Analysis" section.

Issues

Issues that were raised during internal and public scoping regarding elk and vegetation management activity effects on soils included impacts such as erosion of topsoil and subsoil as a result of exposed bare ground, compaction, changes in fertility and nutrients, long-term sustainability and productivity (alteration of fungi and the carbon/nitrogen ratio), flooding, and soil composition.

Assumptions

Potential effects of elk on soils and nutrient cycling were assumed to occur predominantly in the elk core winter range, because that is where elk densities are high and also where most surface waters associated with willow and aspen occur in the primary winter range. It is assumed for analysis that effects of elk use on the primary winter range also occur on the primary summer range; however, the intensity of effects would likely be smaller in the primary summer range because the primary summer range is much larger, elk densities are lower, and forage availability

is higher during the summer growing season. An exception to this would be in the alpine areas, where if elk do concentrate, soils may be affected more severely because vegetation is slower to recover in alpine areas.

Assessment Methods

The technique used to assess impacts on soils from management activities in this document is in accordance with *Management Policies* (NPS 2006b). General soil types, erosion potential, structure, and function were discussed and impacts were analyzed based on reference information, anticipated impacts of management actions by alternative, and professional judgment.

Primary references for this analysis included Binkley et al. 2003, Schoenecker et al. 2001, Schoenecker et al. 2004, Singer et al. 2002, Singer and Schoenecker 2003, and Gehring and Whitman 2002. Future trends used in this analysis were based on modeling by Coughenour (2002) and Schoenecker et al. (2002).

Primary steps for assessing impacts include identifying 1) potential changes in soils from elk and vegetation, 2) whether soil resources are in areas likely to be affected by elk and vegetation management measures, and 3) potential changes in soil productivity, erosion rates, and other soil properties caused by the management actions.

Impact Threshold Definitions

Intensity of Impact

Impacts were evaluated using these thresholds:

Negligible: Soils and nutrient cycles would not be affected, or the effects on soils or nutrient cycles would be below or at levels of detection. There would be no discernable effect on the rate of soil erosion or the ability of the soil to support native vegetation.

Minor: The effects on soil productivity or fertility or nutrient cycles would be detectable. There would be detectable effects on the rate of soil erosion or the ability of the soil to support native vegetation expected in the area.

Moderate: The effect on soil productivity or fertility would be readily apparent and would result in a change to the soil. The rate of soil erosion or the ability of the soil to support native vegetation expected in the area would be appreciably changed. The effect on nutrient cycles would be readily apparent and would change aspects of nutrient cycles.

Major: The effect on soil productivity or fertility would be readily apparent and would substantially change the character of the soils. The actions would have substantial, highly noticeable influences on the rate of soil erosion or the ability of the soil to support native vegetation expected in the area. The effect on nutrient cycles would be substantial and would change aspects of nutrient cycles.

Type and Duration of Impact

Beneficial effects would increase productivity, reduce erodibility, accelerate nutrient cycling, or otherwise enhance the ability of soils to support vegetation.

Adverse effects on soils would reduce productivity, increase erodibility, decelerate nutrient cycling, or otherwise diminish the natural ability of soils to support vegetation.

Duration: Short-term impacts would allow recovery in less than one year. Long-term impacts would require one year or more for recovery.

Impairment

Impairment to soil resources would occur when chemical, physical, or biological changes to soils would reach the point that park purposes could not be fulfilled, or resources could not be experienced and enjoyed by future generations

Alternative 1

Compaction and Bare Ground

Ungulate grazing and hoof action can result in increases in bare ground in Rocky Mountain National Park. Singer et al. found that elk grazing has increased the percent of bare ground by 4.6% and increase bulk density of soils by 1.7% on the elk primary winter range (riparian willow and upland shrub/grassland sites) in an exclosure study in the park (2002).

The potential for bare ground would be expected to continue over time and may increase slightly as elk continue to graze and concentrate in different areas where forage is available on the core winter range. The adverse effect on soils from compaction and bare ground would be long term, local, and minor in the elk core winter range, where densities are the highest of any population that is not artificially fed (Coughenour 2002), because the difference in bare ground between an area without elk and an area with elk is measurable (i.e., 4.6%, when using exclosures). In other areas of the elk primary winter and summer ranges, where elk occur in lower densities, effects would be negligible and adverse.

Erosion

Slight increases in bare ground in willow and upland shrub/grassland communities could lead to increases in erosion in those areas where erosive forces are sufficient (i.e., water flow, wind exposure, slope). However, the majority of the winter ground is on relatively flat slopes; therefore, erosion would only occur on a limited basis from high elk densities in the core winter range. Because the primary summer range would have lower densities of elk, erosion from elk hooves would be limited as well, although effects on small areas on steeper slopes could occur. Effects on soils from erosion under Alternative 1 would be long term, local, and minor in the elk core winter range because of high densities. For other areas of the elk primary winter and summer ranges, where densities are lower, effects would be negligible and adverse.

Observations in Moraine Park show increased bank instability due to less willow cover. No research on elk's effects on bank destabilization has been conducted in Rocky Mountain National Park, although visual observations of bank destabilization in the core winter range and in the Kawuneeche Valley have been made by park staff and researchers. In Yellowstone National Park, a similar system to Rocky Mountain National Park with high numbers of elk, "erosion rates in riparian areas have not yet been comprehensively studied, though it is visually obvious that ungulate use of these areas likely contributes to the movement of soil on some streamside banks through their trailing, wallowing, and rubbing" (NPS 1997). While it is likely that elk make some contribution of erosion through bank destabilization, it is unclear how much. Based on this information, it is likely that increases in erosion from destabilization of banks by elk is minimal; effects on soils would therefore be long term, local, negligible, and adverse throughout the elk range.

Sustainability, Productivity, Fertility, and Nutrient Cycling

Ungulates and their grazing can alter any of the main components of nutrient cycling: pools, fluxes on an annual basis inside and outside their primary winter and summer ranges, or fluxes on a daily basis to habitats within a summer or winter range (Singer and Schoenecker 2003). A pool is the total amount of a given nutrient (e.g., nitrogen) that is found in a given area (e.g., a 5-acre aspen stand); a flux is the amount of a given nutrient that is transferred from one area to another via processes (e.g., elk consuming willow, which is a source of nitrogen, then traveling to mixed conifer habitats and defecating, thereby depositing nitrogen in the mixed conifer habitat).

Because elk numbers are currently at high levels in the park, elk have a greater potential to influence nutrient cycling than if they were at lower numbers. A number of research projects have investigated the effects that elk may be having on nutrient cycling in Rocky Mountain Park under current conditions in different vegetative communities.

Willow and Aspen Communities

Schoenecker et al. (2004) calculated net movement of nitrogen away from aspen and willow communities in the park by tracking elk activities (i.e., feeding or bedding) in aspen, willow, upland shrub, meadow, and mixed conifer communities. Long term losses of soil nitrogen and carbon in willow and aspen communities are predicted to be minimal under current elk population levels, as "the sizes of the soil organic matter C and N pools were also very large relative to annual plant uptake and grazing offtake, which provided a large buffering capacity" (Coughenour 2002). Coughenour's model predicts a 2% loss of soil nitrogen and 6% of soil carbon in the willow vegetation in 50 years. This reduction in available soil nitrogen and carbon over time would be a long-term, local, minor, adverse effect in the core elk winter range, as 2% and 6% are detectable but not substantial reductions. Elk's effects on soils in the primary summer range and the remainder of the elk primary winter range are likely even less, because elk do not congregate in the same densities in these areas, resulting in a negligible, adverse effect.

Singer et al. concluded that nitrogen process and pools were being reduced by elk herbivory in willow and aspen types in the elk primary winter range (2002). Grazed willow areas had half the input of nitrogen when compared to ungrazed exclosures, as well as a 79% lower mineralization rate and a 78% lower nitrate pool (Singer et al. 2002). Annual nitrogen inputs (herbaceous biomass; shrub/leaf litterfall; and elk urine and feces) on grazed short willow sites were 60% of ungrazed sites; on aspen grazed sites, nitrogen inputs were 44% of ungrazed sites. Singer et al. also stated that "at some point, the depletions might result in declines in plant growth and changes in species composition" (2002). Based on this information, the reduction of nitrogen inputs in willow and aspen communities could be considered substantial in the park. This reduction in pools and fluxes in short willow and aspen communities would be considered a long-term, local, moderate, adverse effect in the primary winter range. Due to lower elk densities and increased forage availability during the summer months, effects of elk on nutrient cycling on the primary summer range are likely less than on the primary winter range. Therefore, effects on the primary summer range would be long-term, minor, and adverse.

Upland Shrub

Singer et al. (2003) concluded that nitrogen and carbon abundances were being maintained in the upland grass/shrub type. But in an exclosure study on the elk primary winter range, there has been a decrease in availability of calcium, magnesium, potassium, and phosphorus in the soil by 30% in upland shrub habitats compared to ungrazed exclosure sites (Binkley et al. 2003). Upland shrub habitats are already cation-poor, so grazing in upland shrub could be the cause for this

depletion, as plants respond to herbivory by increasing their uptake of nutrients from soils. This depletion would, over time, affect soil productivity in upland grass/shrub in a measurable, noticeable manner. Therefore, continuation of high elk numbers under this alternative would result in long-term, local, minor-to-moderate, adverse impacts on soils in the elk primary winter range by continuing this depletion of extractable cations and phosphorus. Effects would be minor in the primary summer range due to lower densities and higher available forage.

Mixed Conifer

Nitrogen pools are likely slightly increasing in mixed conifer habitats because elk are transferring it out of willow and aspen areas through feeding in willow and aspen areas and bedding and defecating in mixed conifer areas in the elk primary winter range in the park (Schoenecker et al. 2004). This increase in nitrogen would be beneficial to soils in the mixed conifer habitat, because it would increase soil productivity. Effects on soils on the elk primary winter range would be long term, local, and minor because effects would be readily apparent but would not be large enough to substantially change soil productivity in the mixed conifer habitat. It is assumed that this would also occur on the primary summer range, but because the primary summer range is larger and elk densities are lower, nitrogen inputs would be more widely distributed in the mixed conifer habitat, resulting in long-term, negligible-to-minor benefits.

Microbial Activity

Herbivory has been shown to reduce mycorrhizal levels in the soil and alter species composition (Gehring and Whitham 2002). High levels of elk herbivory in the core winter range on willow and aspen would likely continue to reduce mycorrhizal levels in the soil and change mycorrhizal species composition. This would result in a long-term, local, minor, adverse effect on soils in the core winter range because reductions would be readily apparent if measuring mycorrhizal levels in the soil. Because elk densities and therefore rates of herbivory are lower in other portions of the primary winter range and in the primary summer range, effects would be negligible in these areas.

Flooding, such as that caused by beaver activity, increases microbial action (e.g., nitrogen fixation) in soils (Songster, Alpin and Klotz 1995, Naiman and Melillo 1983). The lowered water table associated with the reduced beaver population in the park would continue to degrade soils by decreasing microbial action in the soil (see "Water Resources" for a more detailed explanation of beaver's role in hydrology). Reduction in microbial activity would reduce soil productivity at a measurable level, but would only occur in localized areas that were previously flooded by beavers. This continued lack of flooding represents a long-term, local, minor, adverse effect on soils and nutrient cycling, as microbial activity is now somewhat reduced in areas where it was naturally higher.

Cumulative Impacts

Bare Ground, Compaction, Erosion, and Flooding

Other actions occurring in the park that could have effects on bare ground, compaction, and erosion include erosion prevention from trail management activities and a willow fencing project in the area of the former Fan Lake. Trail management activities would protect trail soils from eroding, a long-term, local, minor, beneficial effect; willow fencing in a small area would prevent further creation of bare ground by elk, a negligible benefit. Constructing a barn would compact soils and negatively affect soil productivity in a local area by covering the soil with a foundation,

long-term, minor, adverse effects. Revegetation and other vegetation restoration activities would control erosion and reduce bare ground, a long term, minor-to-moderate, beneficial effect on soils. Actions as a result of resource management planning would protect and improve soil characteristics in the park, a long term, regional, moderate, beneficial effect. Exotic vegetation management activities would involve the use of steam and hot water applications, and chemical and mechanical removal of vegetation (which increase erosion locally), a long term, local, minor, adverse effect.

The combination of effects of these plans, projects, and actions on bare ground, compaction, and erosion issues of soils would be long term, park-wide, minor to moderate, and beneficial. Alternative 1 would contribute long-term, minor, adverse effects, for an overall cumulative effect that would be long term, minor, and beneficial.

Nutrient Cycling

Nitrogen deposition from poor air quality would continue to negatively affect nutrient cycling by introducing additional nitrogen into nitrogen-limited systems in the park, such as willow and aspen communities. This change in the nitrogen cycle would result in long-term, regional, moderate, adverse effects on soils. Prescribed fire actions are occurring and will continue to occur in the elk primary winter and summer ranges in the park, causing short-term, minor, adverse effects and long-term, negligible, beneficial effects on soils as a result of the change in soil composition (i.e., reduction in organic matter) and increases in nutrient availability in the soils. Mechanical thinning actions would remove carbon stocks from local areas, a long-term, negligible, adverse effect. Fencing a small area of willows would restrict elk from the area, resulting in a long-term, minor, beneficial effect on nutrient cycling. Constructing a barn would have a long-term, local, minor, adverse effect on soil productivity, as soils would be covered with a permanent structure.

The combination of effects of these plans, projects, and actions would be long term, moderate, and adverse. Alternative 1 would contribute long-term, minor-to-moderate, adverse effects on cumulative effects. When effects of other plans, projects, and actions are combined with effects of Alternative 1, cumulative effects on soils would be long term, moderate, and adverse.

Conclusion

Because the potential for bare ground and increases in bare ground would be slight, the adverse effects on soils from compaction and bare ground would be long term, local, and minor in the core winter range but negligible elsewhere in the elk range. Effects from erosion on soils would be long term, local, negligible to minor, and adverse, again depending on the slope of the local area of the primary elk range. Increased bank instability from reduced willow cover would result in a long-term, local, negligible, adverse effect on soils. In upland shrub areas, a 30% decrease in calcium, magnesium, and other cations would continue to result in a long-term, local, minor-to-moderate, adverse impact on soils in the primary winter range but minor in the primary summer range. Reduction in available soil nitrogen and carbon over time in aspen and willow communities would be a long-term, local, minor, adverse effect. A reduction in overall pools and fluxes of nitrogen and carbon in short willow and aspen areas would be a long-term, local, moderate, adverse effect. Increases in nitrogen inputs to mixed conifer habitats from elk transferring nitrogen from feeding in willow and aspen areas to mixed conifer areas where they bed and defecate, would have long-term, local, minor, adverse effects on mixed conifer on the elk core winter range but negligible-to-minor effects in other portions of the elk range from lower densities and therefore lower nitrogen inputs. Continued high levels of elk herbivory would

likely continue to reduce mycorrhizal levels and change species composition, a long-term, minor, adverse effect on soils in the core winter range, and a negligible adverse effect on the remainder of the elk range. The continued lack of flooding from a reduced beaver population represents a long-term, local, minor, adverse effect on soils from reduced microbial activity.

Cumulative effects on bare ground, compaction, erosion, and flooding of soils would be long term, minor, and beneficial, with Alternative 1 making a long-term, minor, adverse contribution. Cumulative effects on nutrient cycling would be long term, moderate, and adverse, with Alternative 1 contributing long-term, minor-to-moderate, adverse effects.

Impairment of soils within the park would not occur under Alternative 1.

Alternative 2

Compaction and Bare Ground

A large reduction from current population size, fencing of aspen, and redistribution measures would reduce elk densities and grazing pressure in the core elk range, resulting in reduced compaction and less bare ground, based on a documented 4.6% difference in bare ground in ungrazed versus grazed sites in the core winter range (Singer et al. 2002). This reduction in bare ground and compaction would represent a long-term, local, minor, beneficial effect on soils because while the change would not be as great as 4.6%, given that elk would still occur in these areas, it would still be detectable. However, where elk densities are already low in other parts of the primary winter range and the primary summer range, effects of a reduced elk population on bare ground and compaction would be negligible and beneficial.

Short-term effects associated with lethal control activities and research activities conducted in coordination with elk and vegetation management, including temporary capture facilities, herding activities, use of vehicles or horses, and the removal of carcasses, would increase soil compaction and bare ground, although it would be barely noticeable, localized, and recovery would be rapid as long as routes were not reused every year. A temporary capture facility would disturb vegetation and expose some bare ground in a small area. Removal of carcasses could expose bare ground if dragging was necessary. However, again, if routes were not repeatedly used, effects should be minimal. Use of all-terrain vehicles during the summer months and herding with trained dogs and horses could result in some compaction of soils, but because vehicles would not be consistently traveling over the same area, it is unlikely effects would be detectable. Overall, effects would be local, minor, and adverse in both the elk primary winter and summer ranges in the park.

Activities related to mechanical thinning and burning would occur in willow and aspen communities in both the primary winter and summer ranges, causing compaction of soils from vehicles and the exposure of bare ground from prescribed burns. These actions would take place infrequently and in small areas. Effects would be short term (as areas would quickly revegetate), local, minor to moderate (depending on the size of the area), and adverse.

Erosion

Under Alternative 2, the reduction in elk population would be extensive and quick. Bare ground would be replaced with vegetative cover rapidly in the elk core winter range from decreased browsing and increased willow and aspen as a result of fencing of aspen and subsequent beaver reintroduction or recolonization, thereby decreasing the potential for erosion. This benefit to soils

would be long term, local, and minor in the core winter range but negligible in other areas of the elk range, where elk densities would be lower.

Because the current elk population is only having a negligible adverse effect on erosion from bank destabilization, a reduction in the elk population and a related reduction in browsing pressure would negligibly reduce erosion of streambanks.

As mentioned in the "Compaction and Bare Ground" subsection, effects associated with lethal control and vegetation management activities would be short term, local, minor, and adverse. Horses, vehicles, and carcass removal would have the potential to increase erosion, but this would be very limited in extent and would rapidly recover. Also, the temporary capture facility and prescribed burns would likely be on land with a low slope, thereby reducing erosion potential.

Sustainability, Productivity, Fertility, and Nutrient Cycling

Willow and Aspen Communities

If the elk population at Rocky Mountain National Park were reduced by 40%, Schoenecker et al. predict that total soil carbon and nitrogen, net mineralized nitrogen, total shrub carbon, and coarse and fine root carbon would be relatively stable in the long term for uplands and willow communities (2002), instead of the slight decrease predicted with the current elk population level. Coughenour's modeling also reports little change in carbon and nitrogen pools with reduced elk grazing and abundance (2002), again, because soil pools largely outweigh annual plant uptake and grazing offtake. Therefore, effects on nutrient cycling aspects of soils from the maximum reduction of elk would be long term, local, minor, and beneficial in willow communities in the core elk winter range. Effects on nutrient cycling in willow communities in other portions of the primary winter range and the primary summer range would be less because elk effects on nutrient cycling would be spread out over larger areas.

However, nitrogen inputs to short willow communities alone and aspen communities would be expected to increase with a reduction in the elk population and elk densities (from elk redistribution activities). Nitrogen inputs would be less than if there was no elk herbivory in these communities, but would be substantially greater than currently occur. If current nitrogen inputs are 60% of ungrazed sites, a 50% reduction in the elk population could result in nitrogen inputs that are up to 80% of ungrazed sites, a large increase from 60% (Singer et. al. 2002). Therefore, effects on short willow and aspen communities' nitrogen inputs would be long term, local, moderate, and beneficial on the elk primary winter range. Effects of a reduced elk population on the primary summer range would be expected to be less, as elk have less of an influence on nitrogen inputs in the primary summer range due to lower densities; therefore, effects would be long term, minor, and beneficial.

Mechanical thinning of willow and aspen sites would result in increases in nitrogen mineralization and nitrification (Kaye and Hart 1998). This increase in nitrogen cycling rates would occur in small portions of the willow and aspen stands in the elk primary winter and summer ranges. Effects would be detectable; Kaye and Hart measured a more than doubling of nitrogen from nitrogen mineralization in ponderosa pine and bunchgrass that was thinned (1998). Therefore, effects from mechanical thinning would be long term, local, minor, and beneficial.

Prescribed burns would release nitrogen and other nutrients in woody vegetation back into the soils for other plants to readily uptake (Colorado State Forest Service n.d.). This would result in a long-term, minor, beneficial effect on soils by improving access to soil nutrients but it would also

temporarily adversely affect soil composition through the removal of topsoil, resulting in short-term, local, minor, adverse effects.

Willow replantings would slightly increase pools of nitrogen and carbon in small areas under Alternative 2 but would be unmeasurable, a local, negligible, beneficial effect on soils.

Upland Shrub

In upland shrub area soils, increases in availability of calcium, magnesium, potassium, and phosphorus would occur as a result of reduced grazing by elk. This would result in a minor (as increases would be no greater than the 30% elk currently take from upland shrub areas; Binkley et al. 2003), beneficial effect in upland shrub area soils.

Microbial Activity

Reduced levels of elk herbivory on willow and aspen would increase mycorrhizal levels in the soil. This would result in long-term, local, minor, beneficial effect on soils.

Increases in the water table associated with a recolonized or reintroduced beaver population would result in improved retention of water (i.e., flooding and soil saturation) and would increase microbial action in soils (Songster-Alpin and Klotz 1995, Naiman and Melillo 1984), representing a long-term, local, minor, beneficial effect on soils in the core winter range because the increase in microbial activity and subsequent improvement in soil productivity would begin to return to natural productivity levels.

Cumulative Impacts

Bare Ground, Compaction, Erosion, and Flooding

Effects of other plans, projects, and actions on bare ground, compaction, erosion, and flooding would be the same as described for Alternative 1: long term, regional, minor to moderate, and beneficial. Alternative 2's contribution to cumulative effects would be long term, minor, and beneficial from improvements from flooding of soils and slight reductions in bare ground and erosion. Therefore, overall cumulative effects would be long term, minor, and beneficial.

Nutrient Cycling

Effects of other plans, projects, and actions on bare ground, compaction, erosion, and flooding would be the same as described for Alternative 1: long term, moderate, and adverse. Alternative 1 would contribute long-term, minor, beneficial effects on cumulative effects. When effects of other plans, projects, and actions are combined with effects of Alternative 1, cumulative effects on nutrient cycling aspects of soils would be long term, minor, and adverse.

Conclusion

A 60% to 70% reduction of the elk population and redistribution measures would reduce bare ground and compaction and, therefore, erosion, resulting in a long-term, local, minor, beneficial effect on soils. Reduced browsing pressure along riparian areas would likely result in improved bank stabilization, a long term, local, negligible, beneficial effect. Short-term effects associated with the plan's activities would be local, minor, and adverse to soils, except for mechanical thinning and prescribed burning, which would have local, minor-to-moderate, adverse effects on

soils. Effects on nutrient cycling aspects of soils in willow and aspen areas from the maximum reduction of elk would be long term, local, minor, and beneficial, based on Schoenecker et al.'s (2002) and Coughenour's (2002) modeling. Increases in nitrogen inputs would be expected from a reduction in the elk population, resulting in a long-term, local, moderate benefit in the elk core winter range, but minor benefits would occur locally on the remainder of the primary winter range and the primary summer range. In upland shrub areas, increases in cation availability would occur, resulting in a minor, beneficial effect on upland shrub area soils.

Mechanical thinning of willow and aspen sites would result in increased nitrogen mineralization and nitrification in local areas on the elk primary winter and summer ranges where the thinning occurs, a long-term, minor, beneficial effect. Prescribed burns would result in long-term, minor benefits by improving access to soil nutrients, and short-term, local, minor, adverse effects from affecting soil composition. Willow replantings would slightly increase nitrogen and carbon pools, a local, negligible beneficial effect. Upland shrub area soils would experience local, minor benefits. Reduced levels of elk herbivory on willow and aspen would increase mycorrhizal levels in the soil, a long-term, local, minor, beneficial effect on soils. Increases in the water table associated with increases in beaver would represent a long-term, local, moderate, beneficial effect on soils.

Cumulative effects on bare ground, compaction, erosion, and flooding of soils would be long term, minor, and beneficial, with Alternative 2 contributing long-term, minor beneficial effects. Cumulative effects on nutrient cycling would be long term, minor, and adverse, with Alternative 2 contributing long term, minor, beneficial effects.

Impairment of soils within the park would not occur under Alternative 2.

Alternative 3

Compaction and Bare Ground

A 30% to 50% reduction of the current elk population size, fencing of both aspen and riparian willow areas, and elk redistribution would reduce grazing pressure and result in less bare ground (based on a measured difference of 4.6% less bare ground in ungrazed compared to grazed sites) than what currently is present and would be incrementally less than what would occur under Alternative 2. Elk would be restricted from using the fenced areas and would be redistributed, thereby reducing densities and impacts in a given area. This would represent a long-term, local, negligible, beneficial effect on unfenced soils and a long-term, local, minor, beneficial effect on fenced soils in areas of aspen and montane riparian willow on the primary winter and summer ranges, as more elk would congregate in a smaller total area than under Alternative 2.

Short-term effects associated with lethal control activities, research activities, and vegetation management activities, including herding activities, use of vehicles or horses, removal of carcasses, and fencing installation would be the same as those described for Alternative 2.

Erosion

Under this alternative, there would be less recovery of vegetation in areas of the primary summer and winter ranges than under Alternative 2, as elk would continue to forage in unfenced areas and elk numbers would be reduced gradually to the higher end of the natural range. Therefore, soils would continue to be exposed and elk would continue to cause erosion in unfenced areas. A reduction in bare ground and in exposure of soils to erosion would be limited to aspen and willow areas that would be fenced. Based on Singer et al. (2002), a 4.6% reduction of bare ground would

be expected within the fenced areas, which would result in long-term, local, minor benefits to soil from reduced erosion. Negligible, beneficial effects would occur outside of the fenced areas in both the primary winter and summer ranges.

Because the current elk population is having a negligible, adverse effect on erosion from bank destabilization, a reduction in the elk population, fences in aspen and montane riparian willow communities, and a related reduction in browsing pressure would negligibly reduce erosion of streambanks.

Short-term effects associated with lethal control and vegetative management activities would be the same as those described for Alternative 2.

Sustainability, Productivity, Fertility, and Nutrient Cycling

Overall impacts on nutrient cycling would be similar to those described under Alternative 2, although incrementally less due to a higher elk population. However, with regard to carbon and nitrogen transfer out of willow and aspen areas, elk would not contribute to transferring nitrogen and carbon away from the area in fenced areas of aspen and montane riparian willow.

Effects on soils from changes in nutrient cycling from mechanical thinning activities, prescribed burns, and willow replantings would be the same as those described for Alternative 2.

Microbial Activity

Effects on mycorrhizae would be the same as those described for Alternative 2.

Alternative 3 would allow beaver recovery in areas that are fenced, as they would not be competing with elk in these areas and willow would be more likely to recover in these areas. However, unfenced areas would have less potential for beaver recovery and thus would have a smaller area overall where flooding and microbial activity would be increased compared to Alternative 2. Overall benefits to soils from flooding would be long term, local, and minor.

Cumulative Impacts

Bare Ground, Compaction, Erosion, and Microbial Activity

Effects of other plans, projects, and actions on bare ground, compaction, erosion, and flooding of soils would be the same as described for Alternative 1: long term, regional, minor to moderate, and beneficial). Alternative 3's contribution to cumulative effects would be long term, minor, and beneficial from flooding and reductions in bare ground and erosion inside fencing. Therefore, overall cumulative effects would be long term, minor to moderate, and beneficial.

Nutrient cycling

Effects of other plans, projects, and actions on nutrient cycling would be the same as described for Alternative 1: long term, moderate, and adverse. Alternative 3's contribution to cumulative effects would be long term, minor, and beneficial from reductions in elk-related transfer of nitrogen and carbon away from willow and aspen systems in the park. Overall cumulative effects on nutrient cycling would be long term, minor, and adverse.

Conclusion

A 30% to 50% reduction in the elk population in the park, fencing of montane riparian willow and aspen, and elk redistribution would reduce bare ground, compaction, and erosion, resulting in a long-term, local, minor benefit to fenced soils and a local, negligible, beneficial effect on unfenced soils in the elk primary winter and summer ranges. Short-term effects from the plan's activities would result in minor, local, adverse impacts on the primary elk winter and summer ranges, except for mechanical thinning and burning, which would be minor to moderate and occur locally in montane riparian willow and aspen communities, primarily in the winter range. Reduced browsing pressure and fencing would improve bank stabilization, a long-term, local, negligible, benefit in both fenced and unfenced areas.

Overall impacts on nutrient cycling would be similar to those described under Alternative 2: long term, local, minor, and beneficial from increases in soil nitrogen and carbon across the elk primary winter and summer ranges; long term, local, moderate, and beneficial on the elk primary winter range; and minor on the elk primary summer range, although effects would be incrementally greater in fenced areas. Increases in cations and phosphorus on upland shrub areas from a reduction in elk would be the same as described for Alternative 2: a long term, local, moderate benefit in the elk primary winter range but minor in the primary summer range. Effects on soils from changes in nutrient cycling from mechanical thinning activities would be the same as described for Alternative 2: long term, local, minor to moderate, and beneficial. Effects from prescribed burns would be the same as described for Alternative 2: long term, minor, and beneficial and short term, local, minor, and adverse. Effects from willow replantings would also be the same as described for Alternative 2: long term, local, negligible, and beneficial.

Effects on mycorrhizae would be the same as described for Alternative 2: long term, local, minor, and beneficial. Overall benefits from increased flooding of soils would be long term, local, and minor.

Cumulative effects on bare ground, compaction, erosion, and flooding of soils would be long term, minor to moderate, and beneficial, with Alternative 3 contributing long-term, minor, beneficial effects. Cumulative effects on nutrient cycling would be long term, minor, and adverse, with Alternative 3 contributing long-term, minor, beneficial effects.

Impairment of soils within the park would not occur under Alternative 3.

Alternative 4

Compaction and Bare Ground

Effects on soils would be similar to those described for Alternative 3. Elk would be restricted from using the fenced areas and would be redistributed, thereby reducing densities and impacts in a given area. This would represent a long-term, local, negligible, beneficial effect on unfenced soils and a long-term, local, minor, beneficial effect on fenced soils in areas of aspen on the primary elk range and montane riparian willow on the primary winter range. Effects associated with lethal control activities, research activities, and vegetation management activities would be the same as those described for Alternative 2.

Erosion

Effects on soils would be similar to those described for Alternative 3. Effects on soils from reduced browsing pressure would be the same as described for Alternative 3. Effects associated

with lethal control activities and potential beaver recovery or reintroduction would be the same as those described for Alternative 2.

Sustainability, Productivity, Fertility, and Nutrient Cycling

Effects on soils would be the same as those described for Alternative 3.

Microbial Activity

Effects on mycorrhizae would be the same as those described for Alternative 2. Effects on soils from increased flooding would be similar to those described for Alternative 3.

Cumulative Impacts

Cumulative effects would be the same as those described for Alternative 3.

Conclusion

A 30% to 50% reduction in the elk population in the park, fencing of willow and aspen, and elk redistribution would reduce bare ground, compaction, and erosion, resulting in a long-term, local, minor benefit to fenced soils in the winter elk range and a local, negligible, beneficial effect on unfenced soils in the primary winter and summer elk range. Short-term effects from the plan's activities would result in minor, local, adverse impacts on the winter and summer elk ranges, except for mechanical thinning and burning, which would be minor to moderate and occur locally in willow and aspen communities in both the primary winter and primary summer ranges. Reduced browsing pressure and fencing would improve bank stabilization, a long term, local, negligible benefit in both fenced and unfenced areas in the winter and summer elk ranges.

Overall impacts on nutrient cycling would be similar to those described under Alternative 2 (long term, local, minor, and beneficial from increases in soil nitrogen and carbon across the elk primary winter and summer ranges; long term, local, moderate, and beneficial on the elk primary winter range; and minor on the elk primary summer range), although effects would be incrementally greater in fenced areas. Increases in cations and phosphorus on upland shrub areas from a reduction in elk would be the same as described for Alternative 2: a long term, local, moderate benefit in the elk primary winter range but minor in the primary summer range. Effects on soils from changes in nutrient cycling from mechanical thinning activities would be the same as described for Alternative 2: long term, local, minor to moderate, and beneficial. Effects from prescribed burns would be the same as described for Alternative 2: long term, minor, and beneficial as well as short term, local, minor, and adverse. Effects from willow replantings would also be the same as described for Alternative 2: long term, local, negligible, and beneficial.

Effects on mycorrhizae would be the same as described for Alternative 2: long term, local, minor, beneficial. Overall benefits from increased flooding of soils would be long term, local, and minor.

Cumulative effects on bare ground, compaction, erosion, and flooding on soils would be long term, minor to moderate, and beneficial, with Alternative 4 contributing long-term, minor, beneficial effects. Cumulative effects on cycling on soils would be long term, minor, and adverse, with Alternative 4 contributing long-term, minor, beneficial effects.

Impairment of soils within the park would not occur under Alternative 4.

Alternative 5

Compaction and Bare Ground

Effects from elk population reduction would be similar to those described for Alternative 2.

Short-term effects associated with vegetation management and lethal control activities and research activities implemented primarily during the initial phase of wolf release, including temporary capture facilities, herding activities, use of vehicles or horses, removal of carcasses, and fencing installation, would result in the same effects as those described for Alternative 2. In the long term, the impacts of these actions would be reduced to negligible or even no effect as wolves would become the primary management tool to disperse and regulate the elk population.

Erosion

Effects on soils would be similar to those described for Alternative 2. Effects on soils from reduced browsing pressure would be the same as those described for Alternative 2. Effects associated with lethal control and vegetation management activities would be the same as those described for Alternative 2.

Sustainability, Productivity, Fertility, and Nutrient Cycling

Effects from elk population reduction would be similar to those described for Alternative 2. The release of wolves would likely directly contribute negligible, beneficial effects on nutrient cycling and soil productivity because their numbers would be too few to detect any changes.

Microbial Activity

Effects on mycorrhizae would be the same as those described for Alternative 2. Effects from elk population reduction would be similar to those described for Alternative 2.

Cumulative Impacts

Cumulative effects would be the same as those described for Alternative 2.

Conclusion

Effects from elk population reduction on bare ground, compaction, and erosion would be similar to those described for Alternative 2: long term, local, minor, and beneficial as well as short term, minor, and adverse. Overall impacts on nutrient cycling for aspen and willow would be similar to those described under Alternative 2: long term, local, minor, and beneficial from increases in soil nitrogen and carbon across the elk primary winter and summer elk range; long term, local, moderate, and beneficial on the primary winter range; and minor on the elk primary summer range. Increases in cations and phosphorus on upland shrub areas from a reduction in elk would be the same as described for Alternative 2: a long term, local, moderate benefit in the winter elk range but minor in the primary summer range. Effects from mechanical thinning and burning on nutrient cycling would be the same as described for Alternative 2: long term, minor, benefits. Effects on mycorrhizae would be the same as described for Alternative 2: long term, local, minor, beneficial. The release of wolves would likely directly contribute negligible, beneficial effects on nutrient cycling and soil productivity because their numbers would be too few to result in

detectable changes. Effects from increased microbial activity from flooding of soils would be similar to those described for Alternative 2: long term, local, minor, and beneficial.

Cumulative effects on bare ground, compaction, erosion, and flooding of soils would be long term, minor to moderate, and beneficial, with Alternative 5 contributing long-term, minor-to-moderate, beneficial effects. Cumulative effects on nutrient cycling would be long term, minor, and adverse, with Alternative 5 contributing long term, minor, beneficial effects.

Impairment of soils within the park would not occur under Alternative 5.

NATURAL SOUNDSCAPE

Summary of Regulations and Policies

The fundamental mission of the national park system is to conserve park natural and historic resources and to provide for the enjoyment of park resources only to the extent that the resources will be left unimpaired for the enjoyment of future generations. As described in Section 1.4.6 of *Management Polices* (2006b), natural soundscapes are recognized and valued as a park resource in keeping with the NPS mission.

The natural soundscape, sometimes called natural quiet, is the aggregate of all the natural sounds that occur in parks, together with the physical capacity for transmitting natural sounds. Management goals for soundscapes are included in Section 4.9 of *Management Policies* (NPS 2006b) and in *Director's Order 47: Soundscape Preservation and Noise Management* (NPS 2000).

Management Policies requires restoration of degraded soundscapes to the natural condition whenever possible and protection of natural soundscapes from degradation. The National Park Service is directed to "take action or prevent or minimize all noise that, through frequency, magnitude, or duration, adversely affects the natural soundscape or other park resources or values, or that exceeds levels that have been identified as being acceptable to, or appropriate for, visitor uses at the sites being monitored" (NPS 2000).

Director's Order 47: Soundscape Preservation and Noise Management requires, "to the fullest extent practicable, the protection, maintenance, or restoration of the natural soundscape resource in a condition unimpaired by inappropriate or excessive noise sources" (NPS 2000). It also states that "the fundamental principle underlying the establishment of soundscape preservation objectives is the obligation to protect or restore the natural soundscape to the level consistent with park purposes, taking into account other applicable laws" (NPS 2000). Noise is generally considered appropriate if it is generated from activities consistent with park purposes and at levels consistent with those purposes.

Director's Order 47 provides the following policy direction: "Where natural soundscape conditions are currently not impacted by inappropriate noise sources, the objective must be to maintain those conditions. Where the soundscape is found to be degraded, the objective is to facilitate and promote progress toward the restoration of the natural soundscape" (NPS 2000). Where legislation provides for specific noise-making activities in parks, the soundscape management goal would be to reduce the noise to the level consistent with the best technology available, which would mitigate the noise impact but not adversely affect the authorized activity. When a noise-generating activity is consistent with park purposes, "soundscape management goals are to reduce noise to minimum levels consistent with the appropriate service or activity" (NPS 2000).

Methodologies and Assumptions for Analyzing Impacts

Geographic Area Evaluated for Impacts

The geographic area evaluated for impacts on natural soundscapes includes the elk primary winter and summer ranges, as these are the areas most affected by potential activities and primary

habitats for elk in the park. Cumulative effects that would occur both within and outside of these areas were evaluated using the methods described in the "Cumulative Analysis" section.

Issues

Issues that were raised during internal and public scoping regarding elk and vegetation management activity effects on natural soundscapes included impacts from management activities that create noise, such as firearms, vehicle use, and helicopter overflights, and the addition of natural sounds if wolves were released. Because 95% of the park is managed as wilderness, activities associated with lethally removing elk would introduce human-caused noise into the soundscape in undeveloped, sensitive areas of the park. Releasing wolves to the park could potentially change the range of natural sounds in the soundscape.

Assessment Methods

The technique used to assess noise impacts from management activities in this document is in accordance with *Management Policies* (NPS 2006b) and *Director's Order 47: Soundscape Preservation and Noise Management* (NPS 2000). The evaluation method considered noise context, sound characteristics including audibility, and time factors, such as duration and frequency of occurrence. These all interact to determine the degree of impact for an activity. Additional primary references included Kyttala no date, Free Hearing Test no date, LHH 2005, and NIDCD 2005 for decibel level information. Known decibel levels of activities were compared against baseline natural sound levels, measured by Harris, Miller, Miller, and Hanson to determine the effects of the actions on soundscapes (1998). No additional sound measurements were collected, nor was any noise modeling conducted. Because of this, the following analysis can only evaluate sounds on an individual level, and its ability to assess additive impacts on the overall soundscape is limited.

The analysis evaluates only the effects of the alternative actions on the baseline natural soundscape. The effects of all other human-caused noises that occur in or affect the park are considered in the cumulative impact analysis. As described in the "General Methodology" section, the cumulative impact analysis evaluates the effects of the alternative actions in combination with all other past, present, and future actions (in this section, all other human-caused noise) within the geographic area of analysis.

Each element of the alternatives is evaluated for its effect on the baseline natural soundscape in both developed and undeveloped areas. The baseline natural soundscape is the same for both developed and undeveloped areas; however, the acceptable noise context and sound characteristics are different for each of these two settings. The sounds of motorized equipment or large congregations of visitors, for example, are more acceptable in developed areas than in undeveloped areas. The impact thresholds discussed below are different for developed and undeveloped areas to account for the differences in acceptability.

Primary steps for assessing impacts would include 1) identifying existing activities that may be affected by noise from the actions, 2) determining the potential noise levels and duration caused by actions under each alternative, and 3) identifying the impacts on the natural soundscape in potential areas where noise concentrations and the effects of sounds may be of concern.

Context

Rocky Mountain National Park resources most likely to be affected by activities related to elk and vegetation management activities include the park's natural soundscape, wilderness areas, and

noise-sensitive wildlife. Potential impacts of noise on wildlife and wilderness are presented in those sections of the document. Impacts on visitor experience are presented in the "Visitor Use and Experience" section. Analysis in this section is intended to disclose impacts on the natural soundscape specifically, recognizing that sound is an intrinsic part of other resources and values in Rocky Mountain National Park.

Sound Characteristics

Duration and frequency of occurrence of a noise affect the impact that a noise would produce. For example, a loud noise that occurs infrequently and for short time periods may have less of an impact than a quieter noise that occurs over longer time periods and at frequent intervals. Examples of common noise levels would be a firecracker as 150 dBA and quieter noise would be rainfall as 50 dBA (LFHH 2003).

On average, noise levels decrease 6 dBA for every doubling of distance (Mcsquared System Design Group n.d.). For the purposes of this document, noise levels are presented at the source and additionally at 1,000 feet and 1 mile, using this rule to calculate decibel levels at farther distances.

These factors were addressed qualitatively in the impact analysis.

Impact Threshold Definitions

Impacts were evaluated for developed and undeveloped areas of the park using the following thresholds. Developed areas are the areas of the park with facilities and resulting larger concentrations of visitors. Examples are the Beaver Meadows Visitor Center, the Glacier Basin Campground, and the Bear Lake parking area and related facilities. Undeveloped areas lack park facilities other than roads or trails, and concentrations of visitors are usually low. Decibel levels in the thresholds were selected qualitatively by grouping a list of activities ranging from 40 to 140 dBA into rough categories of very low, low, medium, and high noise.

Intensity of Impacts

Undeveloped Areas of Rocky Mountain National Park

Negligible: Natural sounds predominate, although human-caused noise is audible in local areas. Human-caused noise is rarely audible 1000 feet or more from the noise source. When noise is present, it is at very low levels (< 70 dBA at the source) and occurs only for short durations in most of the area.

Minor: Natural sounds predominate. Human-caused noise is present only infrequently and occurs only at low levels (<80 dBA at the source) and for short durations in most of the area. When noise is present, it is rarely audible from 1,000 feet or more from the noise source.

Moderate: Human-caused noise is present infrequently to occasionally at low-to-medium levels (<110 dBA at the source) and durations. Human-caused noise is occasionally audible more than a half mile from the source.

Major: Natural sounds commonly are masked by human-caused noise at low or greater levels for extended periods of time. Human-caused noise can be experienced within a half mile of the source at medium levels (80 to 110 dBA at the source) and durations, and noise levels in these areas occasionally are high (>110 dBA). More than half a mile from the source, the natural

soundscape free from human-caused noise can be experienced less than half the time during the day.

Developed Areas of Rocky Mountain National Park

Negligible: Natural sounds predominate. Human-caused noise is rarely audible from a quarter mile or more from the noise source. When noise is present, it is at low levels (<80 dBA at the source) and occurs only for short durations in most of the area.

Minor: Natural sounds usually predominate. Human-caused noise is present only infrequently and occurs only at low to medium levels (<110 dBA at the source) and for short durations in most of the area. When noise is present, it is rarely audible from one mile or more from the noise source.

Moderate: Human-caused noise is present infrequently to occasionally at medium levels (80-110 dBA at the source) and durations. Human-caused noise is occasionally audible more than one mile from the source.

Major: Natural sounds commonly are masked by human-caused noise at low or greater levels for extended periods of time. Human-caused noise can be experienced within a mile of the source at medium levels (80 -110 dBA at the source) and durations, and noise levels in these areas occasionally are high (>110 dBA at the source). More than a mile from the source, the natural soundscape free from human-caused noise can be experienced less than half the time during the day.

Type and Intensity of Impact

Beneficial impacts would reduce levels of human-created noise in the park or would increase natural sounds in the soundscape.

Adverse impacts would result in higher levels of human-created noise in the park's soundscape.

Duration: Short-term impacts of noise intrusion would last less than two hours in a given 24-hour period. Long-term effects would last longer than two hours in a given 24-hour period.

Impairment

Impairment of the natural soundscape would occur when the action contributes substantially to deterioration of the natural soundscape in the park to the extent that the natural soundscape would be almost completely or completely masked by human-caused noises.

Alternative 1

As described in the "Affected Environment" for Natural Soundscapes, natural background noises range from 30 to 45 dBA (Harris, Miller, Miller, and Hanson 1998). Natural sounds that occur in addition to unidentifiable background noise range from 25 (wind) to 55 (elk bugling) dBA in forested areas; in meadow areas, 26 (wind) to 38 (other animals); and 27 (wind) in tundra areas (Harris, Miller, Miller, and Hanson 1998).

Elk themselves create the largest level of natural sounds in the park (from 46 to 90 dBA). The acoustic study was recorded during September, during the elk rut, when elk bugling is commonly heard. Elk would likely contribute lower levels of natural sounds to the soundscape during other times of the year.

Actions that would occur related to elk and vegetation management with the potential to have effects on soundscapes are discussed below. The conclusion discusses an additive effect on soundscapes that includes all of these actions.

Fencing

Under Alternative 1, fencing activities would be limited to maintaining research plot fencing. Noise intrusions would occur very infrequently and would be likely limited to vehicle use and hand tools. Vehicle use and hand tools other than hammering are less than baseline sound levels at 1,000 feet (30 dBA). Hammering is detectable at 1,000 feet (80 dBA), but would not necessarily be required for maintenance. Therefore, maintenance of research plot fencing would continue to have a negligible, adverse effect on soundscapes in developed and undeveloped areas.

Redistribution Techniques

Minimal redistribution techniques such as pepper spray or mace, cracker rounds, rubber buckshot, rubber slugs, or slingshot, depending on the situation (NPS 2002e), would continue to be used under Alternative 1. They would typically occur in developed areas of the park, although they could occur in undeveloped areas as well.

Cracker shot has a decibel level of up to 150 dBA at the source and would be 90 dBA at 1,000 feet, 84 dBA at one-half mile, and 78 dBA at one mile (LHH 2005). Rifles (.308 caliber used by the park) have a decibel level of up to 156 dBA at the source (Free Hearing Test n.d.) and would be up to 96 dBA at 1,000 feet, up to 89 dBA at one-half mile, and up to 82 dBA at one mile. Shotguns used to fire rubber shot have an equivalent level to that of the rifle. Duration time would be a few seconds for each of these techniques. Pepper spray and slingshot would introduce very little noise to the soundscape.

Effects of redistribution techniques on soundscapes would continue to be short-term, local, negligible, and adverse because of the relative infrequency that the techniques are used.

Aggressive or Injured Animals

Injured animals or elk suspected of having chronic wasting disease would be immobilized with a dart rifle and then lethally injected, or occasionally elk are lethally removed using a rifle or shotgun slug. This occurs minimally and could occur in both developed and undeveloped areas of the park. For animals in accessible areas suspected of having chronic wasting disease, carcasses would be removed, sampled, and disposed of. Activities could occur during the day. Dart rifles are only heard when the gun is fired (up to 94 dBA at the source, depending on model, Straight Shooters n.d.). Current models in the park can only be heard only up to 70 yards away (Watry 2005d). The duration is less than a second.

Removing carcasses would continue to introduce additional noise into the soundscape for short periods of time, from human voices in the forest moving the carcasses and vehicle and winch use.

Because these actions would occur infrequently, dart rifles can only be heard from 70 yards away, and other associated noises would have lower decibel levels, overall effects would continue be short-term, local, negligible, and adverse in both developed and undeveloped areas. Effects, although short-term, would occur periodically for the duration of the plan.

Monitoring

Monitoring elk and vegetation would continue to involve one or more aerial flights during the winter season and several days during the year people would be conducting ground surveys.

Several times during the year, people would be in undeveloped areas of the park for the ground surveys, with activities occurring during daylight hours.

Aerial overflights under Alternative 1 would last one day each, with a potential of at least one overflight to many overflights during the winter season. Helicopters have a decibel level of 105 dBA at the source, can be heard from more than one mile away at lower levels, and the duration can last a few minutes if the helicopter is moving or longer if the helicopter is hovering.

Ground surveys would involve human voices being introduced into undeveloped areas of the park and vehicle use to access survey areas. Vehicles have a decibel level of 70 dBA at the source and can be heard up to 1,000 feet away.

Monitoring would result in short-term, parkwide, negligible-to-major, adverse effects on the natural soundscape depending on the distance from the noise source in undeveloped areas and developed areas. Helicopters would create far-reaching and enduring noises. Short-term effects would periodically occur for the length of the plan.

Cumulative Impacts

Recorded noise intrusions within the park vary from 50 to 105 dBA (Harris, Miller, Miller, and Hanson 1998), and include people, jets, and helicopters. Over the course of one hour, in developed areas, such as Beaver Meadows and a tundra site along Trail Ridge road near Sundance Mountain, only natural sounds could be heard from 1% to 76% of the time. For sites north of Grand Lake and in wilderness (Green Mountain and Big Meadow, near Tonahutu Creek), natural sounds without intrusion could be heard from 75% to 95% of the time. These measurements were all taken during daylight hours, from 11 a.m. to 6 p.m.

These sound measurements demonstrate that depending on where an area is located in the park, natural sounds and existing noise intrusions vary. Tundra areas have the lowest background soundscape; therefore, noise intrusions are more notable. Also, whether an area is located near a developed area or roads can cause considerably more noise intrusions to occur within the area.

A number of ongoing activities occurring within the park involve mechanical thinning operations (for bark beetle and fuels management), which would introduce noise from chain saws and potentially heavy equipment, in the primary winter and summer ranges of the elk population at the same time elk and vegetation management activities would be occurring, causing short-term and long-term, local, moderate, adverse effects. Treating exotic plants on the elk primary winter range outside of wilderness would involve using ATVs, mowers, and trimmers, resulting in short-term, minor-to-moderate, adverse effects. Search and rescue operations can use helicopters. Trail management activities would involve the use of hand tools, chain saws, and potentially, dynamite blasting, and helicopters for inaccessible areas, which would cause short-term, adverse effects on the soundscape that would range from negligible to major.

The Park Omnibus Appropriations Act of 1998 banned the use of low-flying commercial air tours over the park, a short-term, regional, major, beneficial effect. However, a dominant additional noise intrusion would continue to occur from 30 to 70 low-level jets (between 19,000 and 15,400 feet, up to 90 dBA at those distances) flying over the park en route to Denver International Airport, on a daily basis, a short-term, major, adverse effect.

The park's backcountry and wilderness plan provides long-term, regional, moderate, benefits to the natural soundscape by encouraging the limitation of noises into the backcountry, but it is limited to actions on the ground in the park.

Effects of these thinning operations, exotic vegetation management, trail activities, and daily overflights combined with the beneficial aspects of the backcountry plan and the air tour ban, would result in continued long-term, local and regional, major, adverse effects on soundscapes. While beneficial effects from the air tour ban are major, the introduction of noise into the soundscape would still have major, adverse effects from the other noises introduced into the soundscape. At any given time, Alternative 1 could contribute a short-term and long-term, local and regional, minor-to-major, adverse effect, although the actions would occur infrequently. When effects from other actions occurring in the past, present, and foreseeable future that impact soundscapes are combined with actions from Alternative 1, the cumulative effect on soundscapes would be short-term, local and regional, minor-to-major, and adverse.

Conclusion

Maintenance of research plot fencing would have a negligible, adverse effect on soundscapes, as it would continue to occur very infrequently. Effects of redistribution techniques on soundscapes would continue to be short-term, local, negligible, and adverse. Short-term effects would continue to periodically occur for the length of the plan for all management actions of the alternative. Because actions to manage aggressive and injured animals would occur infrequently, dart rifles can only be heard from 70 yards away, and other associated noises would have smaller decibel levels, overall effects on soundscapes would continue to be short-term, local, negligible, and adverse in both developed and undeveloped areas. Monitoring would continue to result in short-term, negligible-to-major, adverse effects on the natural soundscape in undeveloped areas and developed areas. Helicopters would create far-reaching and enduring noises the would occur periodically throughout the life of the plan.

Overall, noise intrusions would continue to be very infrequent and only on occasion would add noise to the overall soundscape that would be detectable above ambient levels (including natural sounds).

Cumulative effects of other plans and projects and the actions of Alternative 1 would continue to be short-term, local and regional, minor-to-major, and adverse.

Impairment of natural soundscape within the park would not occur under Alternative 1.

Alternative 2

Gunshots from suppressed-noise and unsuppressed weapons would occur in the park fairly frequently during the first four years of implementation of Alternative 2 and would decrease in occurrence for the remainder of the plan. Noise intrusions from the use of all-terrain vehicles and snowmobiles, along with road vehicle use, would occur frequently throughout the year during the first four years of the plan and, like the use of weapons, would decrease in occurrence thereafter. Helicopter use would increase from current levels, due to the need to distribute fencing materials to remote locations of both the primary winter and summer elk ranges. The use of helicopters for fencing would occur as needed based on monitoring of vegetation conditions. Thinning and burning activities would increase noise throughout the entire day on occasion for the life of the plan, due to chainsaw use.

A research study evaluating procedures for a live test for chronic wasting disease in elk would be conducted in coordination with elk management activities in the first three years of the plan.

Effects on soundscapes from the capture or darting, anesthetizing, and handling of elk would be the same as those described below for lethal control activities involving darting and use of a capture facility.

Impacts from these activities of Alternative 2 that affect soundscapes are discussed below.

Lethal Removal

Effects from lethal elk removal using subsonic -noise rifles, which have a sound level of 116 dBA at source, 66 dBA at 1,000 feet, 60 dBA at one half mile, and 54 dBA at one mile (Free Hearing Test n.d., Kyttälä n.d., Yeary 2005), would result in short-term, local, negligible-to-minor, adverse effects on soundscape in undeveloped and developed areas. The duration of each noise intrusion would be less than one second, and few noise intrusions from subsonic suppressed-noise weapons would occur. While these effects would be short-term, they would occur periodically for the duration of the plan. These actions would occur more often in the first four years of the plan and would decline over time.

Unsuppressed rifles (156 dBA at source, 96 dBA at 1,000 feet, 89 dBA at one half mile, and 82 dBA at one mile) would be used infrequently under this alternative, but would still have (even though for a brief moment) short-term, local, negligible-to-major depending on the distance from the shooter, adverse effects in undeveloped areas and short-term, local, minor, adverse effects in developed areas. Effects would occur periodically for the duration of the plan.

Effects of darting activities (less than 94 dBA at source; up to 70 yards away; Watry 2005b) would be short-term, local, negligible to minor, and adverse for developed areas of the park and negligible to moderate and adverse for undeveloped areas of the park. Effects would occur periodically for the duration of the plan.

Removal of carcasses (e.g., by foot, use of a litter or sled over frozen ground, pack animal, all-terrain-vehicle, winch, or truck) would create low levels of noise from human voices, animals, and vehicle use, resulting in short-term, negligible, adverse effects in developed areas and negligible to minor, adverse in undeveloped areas that could occur periodically throughout the park. If helicopters were used to remove carcasses from remote areas due to disease management concerns or adaptively to herd elk, effects on soundscapes (105 dBA at the source and can be heard from more than one mile away) would be short-term, potentially parkwide, negligible-to-major, and adverse, depending on the distance from the helicopter. The duration would be brief point-to-point flights.

Capture Facility

Erecting a capture facility with a temporary fence and corral would be a minor disturbance in the short-term. Because installation noises would be less than 80 dBA at 1,000 feet away, and these noises would likely occur for at least two hours in a given day, effects on soundscape would be short-term, local, minor, and adverse in both developed and undeveloped areas.

Once the capture facility, which would likely be located near existing roads, is complete, associated noise would be primarily from vehicles, voices (60 dBA at source), and movement noises of both elk and people. If only road-based vehicles are used (i.e., pickup trucks or jeeps), noise levels would be 70 dBA at the source, dropping to virtually undetectable at a half-mile. If snowmobiles or all-terrain vehicles were needed to access the capture facility, noise levels would be up to 100 dBA at the source, up to 70 dBA at 1,000 feet, and up to 55 dBA at one mile. The combined noise in this area would be relatively low to medium and infrequent, resulting in a short-term, local, minor, adverse effect on soundscape in undeveloped areas during the summer.

Effects on the soundscape would be short-term, local, minor, and adverse in developed areas during the winter, assuming that snowmobiles would be used infrequently. These short-term effects would occur for the duration of the plan.

Vegetation Management

Installing fencing to protect aspen, transporting materials, and vehicle use under Alternative 2 would have a decibel level of 120 dBA at the source; vehicle use would be 70 dBA at the source (NIDCD 2005, LHH 2005). Because noise levels decrease an average of 6 dBA for every doubling of distance, the fencing noise would be approximately 80 dBA at 1,000 feet and vehicle use would be approximately 30 dBA at 1,000 feet.

Noise would be introduced into the soundscape for a short period during the spring, summer, or fall from transporting materials (including potentially by helicopter for backcountry areas) and installing fences.

Because fencing installation would be 80 dBA or greater at 1,000 feet from the noise source, effects on soundscape would be short-term, local, minor, and adverse in undeveloped areas and short-term, local, negligible, and adverse in developed areas. Effects would occur periodically throughout the plan commensurate with the amount of fence installed. If helicopters were used to deliver fencing materials to undeveloped areas of the park, this would have negligible-to-major, and adverse effects, depending on the distance from the helicopter. The duration would be brief point-to-point flights. The effects would occur in both undeveloped and developed areas each day that helicopters transported fencing.

Prescribed fires could occur in either undeveloped or developed areas of the park. They would involve vehicles (70 to 85 dBA at the source, 30 to 55 dBA at 1,000 feet, undetectable at one mile), water pumps such as a Mark III pump (may exceed 120 dBA at source, 60 dBA at 1,000 feet, 45 dBA at one mile), and human voices (60 dBA at the source, undetectable at 1,000 feet). Noises from a prescribed fire could continue for a few days or weeks, although not continuously, and could be detectable for extended periods within a day. Effects on soundscape would be minor to major, short-term, local, and adverse in undeveloped and developed areas of the park and would occur for the duration of the plan.

Mechanical thinning activities could also occur in developed or undeveloped areas of the park. They would involve use of chainsaws (120 dBA at source, 60 dBA at 1,000 feet, 45 dBA at one mile) and vehicles (up to 85 dBA at source, 30 to 55 dBA at 1,000 feet, undetectable at one mile). These thinning activities, depending on the size of the treatment area, could continue for a few weeks at a time in a given area. Chainsaws and heavy equipment could create noise for hours at a given time. Effects of thinning on soundscapes would be short-term, local, moderate, and adverse in undeveloped and developed areas. These effects could occur for the life of the plan.

Redistribution Techniques

Redistribution techniques involving rubber bullets or cracker shells would produce short-duration, localized noise, and would have short-term, local, adverse, and minor effects in developed areas and short-term, local, adverse, and moderate effects in undeveloped areas.

Herding with trained dogs would have negligible impacts in both developed and undeveloped areas. Noise from herding elk by people using noise makers (i.e., pyrotechnic streamers, whistles) and yelling could result in noise levels varying from 50 to 156 dBA at the source (up to 96 dBA at 1,000 feet, up to 90 dBA at a half mile, up to 84 dBA at one mile), and these noises would likely increase in frequency and duration during the maintenance phase of this alternative.

They would occur in local areas across the park, focused on the elk primary winter and summer ranges, and would result in short-term and short-term, local, minor-to-moderate, adverse effects if in an undeveloped area and short-term and short-term, local, negligible-to-moderate, adverse effects if in a developed area. These effects would occur for the duration of the plan and could occur frequently throughout the day.

Use of helicopters as an adaptive management tool for herding would have short-term, negligible-to-major, adverse impacts in both developed and undeveloped areas, as described for carcass removal and fence installation.

Aggressive or Injured Animals

Effects on soundscapes would be the same as described for Alternative 1.

Monitoring

Because monitoring under Alternative 2 would occur more frequently but the individual monitoring events would be similar to what currently occurs, effects on soundscapes would be the same as for Alternative 1.

Cumulative Impacts

Cumulative effects would be similar to what was described for Alternative 1, except that Alternative 2's contribution of noise would be somewhat more frequent, due to increases in helicopter use and redistribution techniques and the addition of unsuppressed weapons and mechanical thinning for elk and vegetation management.

Conclusion

Overall, noise intrusions would be infrequent, with some intrusions lasting for long periods of a day, but predominantly noise intrusions would range from a few seconds to a few hours. Most noise intrusions under this alternative would add noise to the overall soundscape that would be detectable above ambient levels (including natural sounds), primarily in localized areas of the elk primary winter and summer ranges. The exception would be helicopter use for fencing and monitoring, which would add noise intrusions to areas adjacent to the elk range. Activities would be unlikely to occur concurrently; therefore, effects would not be additive. Individual effects are listed below.

Effects from lethal removal of elk using suppressed-noise weapons would result in short-term, local, minor, adverse effects on soundscape in undeveloped and developed areas. This action would occur more often in the first four years of the plan and would decline over time. Unsuppressed weapons would be used infrequently under this alternative, but would still have short-term, local, negligible-to-major adverse effects (even though for a brief moment) on undeveloped areas and short-term, local, minor adverse effects on developed areas. Effects of darting activities associated with lethal reduction activities or research activities would be short-term, local, and negligible to minor for developed and negligible to moderate for undeveloped areas. Removal of carcasses would create low levels of noise from human voices, animals, and vehicle use, resulting in short-term, negligible, adverse effects in developed areas and negligible to minor, adverse in undeveloped areas that could occur periodically throughout the park. If helicopters were used to remove carcasses from remote areas, effects on soundscapes would be

short-term, negligible-to-major, and adverse, depending on the distance from the helicopter, and would occur periodically particularly in the first four years of the plan.

Erecting a capture facility with a temporary fence and corral for lethal reduction activities would have short-term, local, minor adverse effects on soundscapes in either developed or undeveloped areas, because installation noises would not carry long distances. Noises from vehicles, including potentially snowmobiles or all-terrain vehicles, accessing the capture facility would have short-term, local, minor, adverse effects on soundscapes in developed and undeveloped areas.

Effects from fencing installation would be short-term, local, minor, and adverse in undeveloped areas and short-term, local, negligible, and adverse in developed areas because of infrequent hammering noises. However, if helicopters were used also, effects would increase to short-term, negligible-to-major, and adverse. These effects would occur periodically throughout the life of the plan.

Effects on the soundscape from prescribed burns would be minor to major in intensity and short-term, local, and adverse in both developed and undeveloped areas. Mechanical thinning activities could occur for days up to weeks, and noises would continue for hours at a time, resulting in short-term, local, moderate, adverse effects on soundscapes in developed and undeveloped areas.

Effects from redistribution techniques would be short-term, local, moderate, and adverse in undeveloped areas; short-term, local, minor, and adverse in developed areas. Herding would have short-term and short-term, local, negligible to major, adverse impacts in developed and undeveloped areas, depending on the type of herding (trained dogs, people, or helicopters as an adaptive tool). Effects on soundscapes from actions to manage aggressive or injured animals would be the same as described for Alternative 1: short-term, local, negligible, and adverse. Effects from monitoring would be the same as for Alternative 1: short-term, parkwide, major, and adverse.

Aside from installing the capture facility, all other actions could occur periodically for the duration of the plan.

Cumulative effects would be similar to those described for Alternative 1: short-term, local and regional, minor to major, and adverse, although Alternative 2's contribution of adverse effects would be more frequent.

Impairment of natural soundscape within the park would not occur under Alternative 2.

Alternative 3

Lethal reduction activities using firearms would occur less frequently than under Alternative 2, due to the higher population target for elk of this alternative. Noise intrusions from the use of all-terrain vehicles and snowmobiles, along with road vehicle use, would occur frequently throughout the year during the first four years of the plan and, like the use of weapons, would decrease in occurrence thereafter. Helicopter use would increase from current levels and from Alternative 2, due to the need to distribute a larger amount of fencing materials to remote locations of both the primary winter and summer elk ranges. The use of helicopters for fencing would occur for the first four years of the plan in a phased approach. Thinning and burning activities specific to this alternative would increase noise throughout the entire day on occasion for the life of the plan due to chainsaw use.

Research activities conducted in coordination with elk reduction activities would have similar effects on natural soundscapes as described for Alternative 2.

Impacts from these activities of Alternative 2 that affect soundscapes are discussed below.

Lethal Removal

Effects from lethal removal using subsonic ammunition and suppressed-noise weapons would have the same effect as described for Alternative 2. However, noise-suppressed weapons would be used less frequently, as lethal removal levels would be lower. The use of unsuppressed weapons under this alternative in the first four years would have short-term, local, negligible to major effects in undeveloped areas and short-term, local, minor, adverse effects in developed areas. Effects would occur at this level, though, for the duration of the plan on a periodic basis.

Darting activities for lethal reduction activities and research activities would have the same effect as under Alternative 2.

Removal of carcasses would have the same effects on soundscapes as described for Alternative 2 but the effects would not decline after the first four years.

Vegetation Management

Under this alternative fences would be installed to protect 160 acres of aspen and 440 acres of willow on the primary summer and winter ranges. Fencing under Alternative 3 would be more extensive than under Alternative 2, as willows would also be fenced, resulting in a nearly four-fold increase in the amount of fencing. The intensity of individual short-term effects would be the same, but would occur more frequently throughout the first four years of the plan, when fencing installation would occur.

Effects on soundscapes from prescribed fire and mechanical thinning would be the same as described for Alternative 2.

Redistribution Techniques

Redistribution techniques under Alternative 3 would have the same intensity level as under Alternative 2 but would occur more frequently.

Effects of herding on soundscapes would be the same as described in Alternative 2 but would occur more often throughout the year.

Aggressive or Injured Animals

Effects of actions towards aggressive or injured animals would be the same as described for Alternatives 1 and 2.

Monitoring

Effects of monitoring would be the same as described for Alternative 2.

Cumulative Impacts

Cumulative effects would be similar to what was described for Alternative 2.

Conclusion

Overall, noise intrusions would be infrequent, with some intrusions lasting for long periods of a day, but noise intrusions would generally range from a few seconds to a few hours. Most noise intrusions under this alternative would add noise to the overall soundscape that would be

detectable above ambient levels (including natural sounds), primarily in localized areas of the elk primary winter and summer ranges. The exception would be helicopter use for fencing and monitoring, which would add noise intrusions to areas adjacent to the elk range. The more extensive use of helicopters for transporting materials for fencing than under Alternative 2 would cause effects with the same intensity level but occurring more frequently. Use of helicopters would be much greater than currently occurs for elk and vegetation management. Activities would be unlikely to occur concurrently; therefore, effects would not be additive. Individual effects are listed below.

Effects from lethal removal using subsonic suppressed-noise weapons would have the same effect as described for Alternative 2: short-term, local, minor, adverse effects in developed and negligible to minor in undeveloped areas. Unsuppressed weapons would be used frequently under this alternative, because of the reduced level of lethal removal compared to Alternative 2, and would have short-term, local, negligible to major effects in undeveloped areas (depending on the distance from the shooter), and short-term, local, minor, adverse effects in developed areas. Darting activities for lethal reduction activities and research activities would have the same effect as under Alternative 2: short-term, local, negligible to moderate, and adverse. Removal of carcasses would have the same effects on soundscapes as described for Alternative 2: short term, negligible, and adverse.; or short-term, negligible to major, and adverse if helicopters were used.

Fencing under Alternative 3 would be more extensive than under Alternative 2, as willows would also be fenced, but overall effects would be the same: short-term, local, minor, and adverse in undeveloped areas and short-term, local, negligible, and adverse in developed areas; if helicopters were used, effects would be short-term, parkwide, negligible to major, and adverse. Effects on soundscapes from prescribed fire (short-term, local, minor to major, and adverse) and mechanical thinning (short-term, local, moderate, and adverse) would be the same as described for Alternative 2.

Redistribution techniques under Alternative 3 would have the same intensity level as under Alternative 2: short-term, local, minor, and adverse in developed areas; short-term, local, moderate, and adverse in undeveloped areas, but would occur more frequently. Effects of herding on soundscapes would be the same as described in Alternative 2, but they would occur more often throughout the year: short-term, negligible-to-major impacts from herding with trained dogs or people with noisemakers, or helicopters as an adaptive management tool. Effects of actions towards aggressive or injured animals would be the same as described for Alternatives 1 and 2: short-term, local, negligible, and adverse. Effects of monitoring would be the same as described for Alternatives 1 and 2: short-term, parkwide, negligible to major, depending on the distance from the helicopter, and adverse.

Cumulative effects would be similar to those described for Alternative 2: short-term, local and regional, minor to major, and adverse, with Alternative 3 contributing a long-term, regional, major, adverse effect.

Impairment of natural soundscape within the park would not occur under Alternative 3.

Alternative 4

Levels of effect of actions from Alternative 4 on soundscapes would be essentially the same as described for Alternative 3, although use of dart guns for fertility control would contribute additional periodic, short-term, negligible, adverse effects by adding human-caused noise to the soundscape.

Research activities conducted in coordination with elk reduction activities would have similar effects on soundscapes as described for Alternative 2.

Impacts on soundscapes from these activities of Alternative 4 that affect soundscapes are discussed below.

Lethal Removal

Effects from lethal removal using suppressed-noise weapons would be the same as described for Alternative 3. Effects from using unsuppressed weapons would also be the same as described for Alternative 3.

Effects of darting activities for lethal reduction actions and research activities would be the same as described for Alternative 2.

Removal of carcasses would have the same effects on soundscapes as described for Alternative 3.

Fertility Control

Targeted female elk would be injected with fertility treatments via dart rifles for elk population management. Dart rifles are only heard when the gun is fired and only up to 70 yards away (Watry 2005d). Depending on whether annual or multi-year fertility treatment would be used, treatments could occur every year in the summer months. Annual treatments would involve increased effort and, therefore, increased noise introduced into the environment. If annual fertility treatments were used on elk, effects on soundscape would be short-term, local, and negligible to moderate, depending on the distance from the activity, in developed and undeveloped areas. These effects would occur on a yearly basis for the life of the plan. Were multi-year fertility treatments to be chosen, effects on soundscapes would be also be short-term, local, negligible to moderate, and adverse in developed and undeveloped areas. These effects could occur on a yearly basis for some targeted elk or every three years for all targeted elk.

Capture Facility

Erecting and using a temporary capture facility for fertility control actions would have the same effects as described for Alternative 2.

Vegetation Management

Under this alternative fences would be installed to protect 160 acres of aspen on the primary winter and summer ranges and 260 acres of willow habitat on the primary winter range. Effects on soundscape from fencing would be the same as described for Alternative 3.

Effects on soundscape from prescribed fire and mechanical thinning would be the same as described for Alternative 2.

Redistribution Techniques

Aversive conditioning techniques under Alternative 4 would have the same intensity level as under Alternative 3.

Effects of herding on soundscapes would be the same as in Alternative 3.

Aggressive or Injured Animals

Effects of actions towards aggressive or injured animals would be the same as described for Alternatives 1 and 2.

Monitoring

Effects of monitoring would be the same as described for Alternative 2.

Cumulative Impacts

Cumulative effects would be similar to those described for Alternative 2.

Conclusion

As stated for Alternative 3, overall noise intrusions would be infrequent, with some intrusions lasting for long periods of a day, but predominantly noise intrusions would range from a few seconds to a few hours. Most noise intrusions under this alternative would add noise to the overall soundscape that would be detectable above ambient levels (including natural sounds), primarily in localized areas of the elk primary winter and summer ranges. The exception would be helicopter use for fencing and monitoring, which would add noise intrusions to areas adjacent to the elk range. The more extensive use of helicopters for transporting materials for fencing than under Alternative 2 would cause effects with the same intensity level but occurring more frequently. Use of helicopters would be much greater than currently occurs with regards to elk and vegetation management. Activities would be unlikely to occur concurrently; therefore, effects would not be additive. Individual effects are listed below.

Effects from lethal removal using suppressed-noise weapons would be the same as described for Alternative 3: short-term, local, minor, adverse effects in developed and negligible to minor in undeveloped areas. Effects from using unsuppressed weapons would also be the same as described for Alternative 3: short-term, local, negligible to major effects in undeveloped areas and short-term, local, minor, adverse effects in developed areas.

Effects of darting activities for lethal reduction actions and research activities would be the same as described for Alternative 2: short-term, local, negligible to moderate, and adverse for developed and undeveloped areas of the park.

Removal of carcasses would have the same effects on soundscapes as described for Alternative 3: short-term, negligible, and adverse. If helicopters were used the adverse effect would be short-term, parkwide, and negligible to major.

With fertility control, dart gun use, human activity, and annual treatments would result in short-term, local, and negligible to moderate effects, depending on the distance from the activity, on soundscapes in both developed and undeveloped areas.

Erecting and using a temporary capture facility for fertility control activities would have the same effects as described for Alternative 2: short-term, local, minor adverse effects in developed and undeveloped areas. Redistribution techniques under Alternative 4 would have the same intensity level as Alternative 3: short-term, local, adverse, and minor in developed areas and moderate in undeveloped areas. Effects of herding on soundscapes would be the same as in Alternative 2: short-term, negligible-to-major impacts from herding with trained dogs or people with noisemakers, and helicopters if used adaptively.

Effects on soundscape from fencing would be the same as described for Alternative 3: short-term, local, minor, and adverse in undeveloped areas; short-term, local, negligible, and adverse in developed areas; if helicopters were used, effects would be short-term, parkwide, major, and adverse. Effects on soundscape from prescribed fire (short-term, local, minor to major, adverse) and mechanical thinning (short-term, local, moderate, and adverse) would be the same as described for Alternative 2.

Effects of actions towards aggressive or injured animals would be the same as described for Alternatives 1 and 2: short-term, local, negligible, and adverse.

Effects of monitoring would be the same as described for Alternative 2: short-term, parkwide, negligible to major, depending on the distance from the helicopter, and adverse.

Cumulative effects would be similar to those described for Alternative 2 (short-term, local and regional, minor to major, and adverse), with Alternative 4 contributing a long-term, regional, major, adverse effect.

Impairment of natural soundscape within the park would not occur under Alternative 4.

Alternative 5

Levels of effect of actions from Alternative 5 on soundscapes would be similar to those described for Alternative 2, although the release of wolves would introduce additional human noises, herding and aversive condition activities would not take place, and wolves would restore the natural sound of howling to the soundscape.

Research activities conducted in coordination with elk reduction activities would have similar effects on soundscapes as the use of darting to anesthetize animals as described for Alternative 2.

Impacts on soundscapes from activities of Alternative 5 that affect soundscapes are discussed below.

Wolves

The first phase of wolf release, would involve releasing a small number of wolves into the park. The initial release process would likely involve vehicles and human voices (60 dBA), a short-term, local, negligible, adverse effect on either the developed or undeveloped area the wolves are released in. If wolves are recaptured for whatever reason, the effect of vehicles and humans would be the same as the initial release. Were wolves to be adversely conditioned or lethally removed by dart gun or rifle, effects on soundscapes would be short term, local, negligible to moderate, and adverse for developed or undeveloped areas.

After the first phase, the wolf population would be allowed to increase in the park. Depending on the number of wolves present in the park, effects of wolves' howling on the park's soundscape could vary from minor to moderate in intensity; would be short-term, parkwide, and beneficial; and would occur at least for the length of the plan. Effects would be beneficial because the National Park Service views restoration of the natural soundscape to be a goal of soundscape management (NPS 2000).

Wolf monitoring could involve the use of helicopters to retrieve wolves if wolves approached the boundary of the park. This would result in a short-term, major, adverse effect on soundscapes.

Lethal Removal

Effects from lethal removal using suppressed-noise weapons would be similar to what was described for Alternative 3. Effects from using unsuppressed weapons would also be the same as described for Alternative 3.

Effects of darting activities for lethal reduction actions and research activities would be the same as described for Alternative 2.

Removal of carcasses would have the same effects on soundscapes as described for Alternative 2.

Capture Facility

Erecting and using a temporary capture facility for lethal reduction actions would have the same effects as described for Alternative 2.

Vegetation Management

Effects on soundscape from fencing would be the same as described for Alternative 2. Effects on soundscape from prescribed fire and mechanical thinning would be the same as described for Alternative 2.

Aggressive or Injured Animals

Effects of actions towards aggressive or injured animals would be the same as described for Alternative 2.

Monitoring

Aside from wolf monitoring (described above under the "Wolves" subsection), effects of monitoring would be the same as described for Alternative 2.

Cumulative Impacts

Cumulative effects and Alternative 5's contribution would be similar to those described for Alternative 1. However, Alternative 5's contribution of noise would be more frequent due to redistribution techniques and the addition of unsuppressed weapons and mechanical thinning for elk and vegetation management and due to increases in helicopter use for wolf monitoring and adverse conditioning. Also, under Alternative 5, wolves would be released in the park, a short-term, minor to moderate, benefit for the soundscape.

Conclusion

As stated for Alternative 2, overall noise intrusions would be infrequent, with some intrusions lasting for long periods of a day, but noise intrusions would generally range from a few seconds to a few hours. Most noise intrusions under this alternative would add noise to the overall soundscape that would be detectable above ambient levels, including natural sounds, primarily in localized areas of the elk primary winter and summer ranges. The exceptions would be the beneficial effect of restoring the sound of wolves to soundscape and the noise intrusions in more extended areas of the park from helicopter use for fencing and monitoring. Activities would be unlikely to occur concurrently; therefore, effects would not be additive. Individual effects are listed below.

The initial release process would have a short-term, local, negligible, adverse effect on soundscapes from introducing vehicle and human voice noises. Were wolves to be adversely conditioned or lethally removed, effects on soundscape would be short-term, local, negligible to moderate, and adverse for developed and undeveloped areas. Depending on the number of wolves present in the park, effects of wolves' howling on the park's soundscape could vary from minor to moderate in intensity; would be short-term, parkwide, and beneficial; and would occur at least for the length of the plan. Wolf monitoring and recapture efforts would result in a short-term, major, adverse effect on soundscapes, if helicopters were used.

Effects of lethal removal using suppressed-noise weapons would be the same as described for Alternative 3 but last throughout the life of the plan: short-term, local, minor, and adverse in developed and negligible to minor in undeveloped areas. Effects from using unsuppressed weapons would also be the same as described for Alternative 3: short-term, local, and negligible to major in undeveloped areas and short-term, local, minor, and adverse in developed areas).

Effects of darting activities for lethal reduction actions and research activities would be the same as described for Alternative 2: short-term, local, negligible to moderate, and adverse for developed and undeveloped areas of the park.

Removal of carcasses would have the same effects on soundscapes as described for Alternative 2: short-term, negligible, and adverse or short-term, parkwide, negligible to major, and adverse if helicopters were used as an adaptive management tool. All lethal removal actions would end after the first four years of the plan.

Erecting and using a temporary capture facility for lethal reduction actions would have the same effects as described for Alternative 2: short-term, local, minor, and adverse in developed and undeveloped areas. Effects of herding on soundscapes would be the same as in Alternative 2: short-term, negligible to major impacts from herding with trained dogs or people with noisemakers, and helicopters if used adaptively.

Effects on soundscapes from fencing would be the same as described for Alternative 3: short-term, local, minor, and adverse in undeveloped areas; short-term, local, negligible, and adverse in developed areas; if helicopters were used, effects would be short-term, parkwide, negligible to major, and adverse, depending on the distance from the helicopter. Effects on soundscape from prescribed fire (short-term, minor to major, local, and adverse) and mechanical thinning (short-term, local, moderate, and adverse) would be the same as described for Alternative 2.

Effects of actions towards aggressive or injured animals would be the same as described for Alternatives 1 and 2: short-term, local, negligible, and adverse.

Effects of monitoring would be the same as described for Alternative 2: short-term, parkwide, negligible to major, and adverse.

Cumulative effects would be similar to those described for Alternative 1 (short-term, local to regional, minor to major, and adverse), although Alternative 5's contribution (long-term, regional, major, and adverse) would be more frequent.

Impairment of natural soundscape within the park would not occur under Alternative 5.

WILDERNESS

Summary of Regulations and Policies

Wilderness Act

The Wilderness Act, passed on September 3, 1964, established a national wilderness preservation system, "administered for the use and enjoyment of the American people in such manner as will leave them unimpaired for future use and enjoyment as wilderness, and so as to provide for the protection of these areas, the preservation of their wilderness character, and for the gathering and dissemination of information regarding their use and enjoyment as wilderness" (16 United States Code Section 1131). The Wilderness Act further defined wilderness as "an area of undeveloped Federal land retaining its primeval character and influence, without permanent improvements or human habitation, and which is protected and managed to preserve its natural conditions" (16 United States Code Section 1131). The Wilderness Act gives the agency managing the wilderness responsibility for preserving the wilderness character of the area and devoting the area to the public purposes of recreational, scenic, scientific, educational, conservation, and historical use (16 United States Code Section 1133). Certain uses are specifically prohibited, except for areas where these uses have already become established. The act states that "there shall be no commercial enterprise and no permanent road within any wilderness area designated by this chapter and except as necessary to meet minimum requirements for the administration of the area . . . , there shall be no temporary road, no use of motor vehicles, motorized equipment or motorboats, no landing of aircraft, no other form of mechanical transport, and no structure or installation within any such area" (16 United States Code Section 1133).

NPS Management Policies

The fundamental mission of the national park system is to conserve park natural and historic resources and to provide for the enjoyment of park resources only to the extent that the resources will be left unimpaired for the enjoyment of future generations. As described in section 1.4.6 of *Management Polices* (NPS 2006b), wilderness is recognized and valued as a park resource in keeping with the NPS mission.

Management Policies states that "the National Park Service will take no action that would diminish the wilderness suitability of an area possessing wilderness characteristics until the legislative process of wilderness designation has been completed…All management decisions affecting wilderness will further apply the concepts of "minimum requirements" for the administration of the area regardless of wilderness category" (NPS 2006b).

Director's Order #41: Wilderness Preservation and Management

Director's Order #41: Wilderness Preservation and Management was developed to provide accountability, consistency, and continuity to NPS wilderness management efforts and to otherwise guide NPS efforts in meeting the requirements set forth by the Wilderness Act of 1964. Director's Order #41 interprets the Wilderness Act and consolidates its requirements and all applicable *Management Policies* to set guiding principles for all NPS units to determine wilderness suitability and appropriately manage those lands. Lands identified as being suitable for wilderness designation, wilderness study areas, and recommended wilderness (including recommended and potential wilderness) must also be managed to preserve their wilderness

character and values in the same manner as "designated wilderness" until Congress has acted on the recommendations (NPS 1999a). Director's Order 41 sets forth guidance for applying the minimum requirement concept to protect wilderness and for the overall management, interpretation, and uses of wilderness. With regards to natural resource management in wilderness, it states, "Management intervention should only be undertaken to the extent necessary to correct past mistakes, the impacts of human use, and the influences originating outside of wilderness boundaries" (NPS 1999a).

Backcountry and Wilderness Management Plan and Environmental Assessment

Rocky Mountain National Park developed a backcountry and wilderness management plan in 2001 to define wilderness management policies and actions at the park; to have a method of identifying the park's wilderness vision, long range management goals, intermediate objectives, and actions and options to meet those objectives; and to serve as a working guide for staff who manage the wilderness resource. This plan include standards for using motorized equipment and mechanical transport in non-emergency actions, which are in part based on season of year, day of week, and time of day.

Methodologies and Assumptions for Analyzing Impacts

Geographic Area Evaluated for Impacts

The geographic area evaluated for impacts on wilderness includes designated and recommended wilderness that occurs in the elk primary winter and summer ranges. Cumulative effects that would occur both inside and outside these areas were evaluated using the methods described in the "Cumulative Analysis" section.

Issues

Issues that were raised during internal and public scoping regarding elk and vegetation management activity effects on wilderness included

- Using vehicles to access areas and mechanical equipment where lethal control actions and carcass removal would be implemented could affect wilderness and wilderness values.
- Fencing could adversely affect the character of wilderness.
- The redistribution of the elk population has affected wilderness character.
- The condition of the vegetative communities that comprise wilderness has been degraded.
- High levels of elk herbivory would continue to alter vegetative conditions within wilderness.
- Wildlife species composition found in wilderness has changed.

Assumptions

Assumptions specific to the impact topic of wilderness are the following:

- Actions that would be taken in wilderness would attempt to be consistent with the park's backcountry management plan (NPS 2001).

Actions not consistent with the plan would require preparation of a minimum requirement and minimum tool analysis.

Assessment Methods

As directed by Director's Order 41, lands identified as being suitable for wilderness designation, wilderness study areas, and recommended wilderness must be managed to preserve their wilderness character and values in the same manner as designated wilderness. Therefore, this analysis regards all lands identified as suitable for wilderness designation as the same and offers no distinction in the impact analysis.

The technique used to assess wilderness from management activities in this document is in accordance with *Management Policies* (NPS 2006b) and *Director's Order 41: Wilderness Preservation and Management* (NPS 1999a). The evaluation method considered primeval character and the influence of wilderness, preservation of natural conditions (including lack of manmade noise), primitive and unconfined recreation for the public, and outstanding opportunities for solitude. These all interact to determine the degree of impact for an activity.

Steps for assessing impacts included: 1) identifying wilderness areas in the park that may be affected by actions of the plan and 2) determining the potential impacts on wilderness caused by actions under each alternative.

These analyses of impacts on wilderness are qualitative and are assessed given the degree to which elk and vegetation management actions would change compared to existing management conditions.

Minimum Requirement / Minimum Tool Analysis

The implementation of some actions associated with the action alternatives of the elk and vegetation management plan would require a minimum requirement analysis. The rationale for the use of chainsaws, off-road vehicles, rifles, noisemakers, trained herding dogs, horses below timberline, fencing, helicopters, and other motorized tools in and over wilderness is included in the minimum requirement analysis provided in Appendix G. The primary reasons for using motorized tools are access concerns, worker safety, and minimization of implementation time, thus resulting in a shorter period of potential effects on wilderness values. Final determination of what methods would be used for site-specific actions to manage elk and vegetation will be further evaluated and determined when the National Park Service completes the minimum tool analysis prior to implementation of actions of this plan/EIS.

Impact Threshold Definitions

Intensity of Impact

Impacts were evaluated using these thresholds:

Negligible: Impacts would have no discernable effect on wilderness resources. Natural conditions would prevail, including a lack of human-made noise. Primeval character and the influence of wilderness would remain unchanged. There would be outstanding opportunities for solitude or a primitive and unconfined type of recreation.

Minor: Impacts would be slightly detectable within areas of the wilderness. Natural conditions would predominate, with minimal human-made noise. Primeval character and the influence of

wilderness would be slightly affected. Outstanding opportunities for solitude or a primitive and unconfined type of recreation would prevail.

Moderate: Impacts would be readily apparent within areas of the wilderness. It would be apparent that natural conditions have changed within such areas, including to the level of human-made noise. Primeval character and the influence of wilderness would be noticeably affected. Opportunities for solitude or a primitive and unconfined type of recreation would be altered in limited areas of the wilderness.

Major: Impacts would substantially alter the wilderness resource in the elk primary winter and summer ranges. Natural conditions would have been substantially changed, including the level of human-made noise. Primeval character and the influence of wilderness would be substantially affected. Opportunities for solitude or a primitive and unconfined type of recreation would be altered throughout the wilderness.

Type and Duration of Impact

Beneficial impacts would improve wilderness or wilderness values.

Adverse impacts would introduce human-caused changes to wilderness or wilderness values.

Duration: With short-term impacts, wilderness values or resources would recover in less than one year after human intrusion. With long-term impacts, wilderness values or resources would take one year or more to recover to recover after human intrusion.

Impairment

Impairment to wilderness would occur when the action contributes substantially to deterioration of the wilderness in the park to the extent that the characteristics that meet the criteria for consideration and classification as wilderness would be eliminated within the park.

Alternative 1

Elk Management

As stated in the "Purpose of and Need for Action" section of this document, the Rocky Mountain National Park / Estes Valley elk population is larger, less migratory, and more concentrated than it was under natural conditions (prior to the mid-1800s). As a result, aspen and willow communities that support high levels of biodiversity are declining, and herbaceous vegetation is grazed at high levels in areas on the elk range where elk are concentrating. A large portion of this elk population's primary winter and summer ranges occurs within the proposed, recommended, and designated wilderness of Rocky Mountain National Park. Elk have been documented to have degraded vegetation within their primary winter range, nearly half of which lies within wilderness areas in the park. Modeling by Coughenour shows that under current management, the elk population would remain at around the same level as currently exists in the park and that degradation of aspen and willow communities would continue (2002). Thus, continuing current management conditions under Alternative 1 would result in the continuing degradation of vegetation in portions of wilderness in the primary winter range, and in the Kawuneeche Valley, although to a lesser degree because of lower elk densities. Changes in vegetation are highly noticeable and have reduced wilderness values in areas of wilderness where aspen and willow vegetation is heavily degraded. Because wilderness values would be degraded by continuing current management at a level that is readily apparent to those visiting the area in search of

untrammeled wilderness, effects on wilderness under Alternative 1 would be long term, moderate, and adverse and would occur range-wide in localized areas of wilderness in the elk primary winter and summer ranges where elk have degraded vegetative conditions.

Fencing

Under Alternative 1, fencing activities would be limited to maintaining research plot fencing. In wilderness areas, hand tools would be used for repairs per the minimum requirement concept, which would have no discernable effect on wilderness values. This action would result in local, negligible, adverse effects on wilderness.

Redistribution Techniques

Minimal redistribution techniques (pepper spray or mace, cracker rounds, rubber buckshot, rubber slugs, or slingshot, depending on the situation; NPS 2002e) would continue to be used under Alternative 1. They would typically occur throughout the elk range, which includes wilderness. The infrequent use of techniques that would create loud, but short-term, human-made noises and visual intrusions in wilderness would be slightly detectable to a human visitor to wilderness, resulting in short-term, local, minor, adverse effects on wilderness in the elk primary winter range. These short-term effects would occur periodically for the duration of the plan.

Aggressive or Injured Animals

Injured animals, or elk suspected of having chronic wasting disease, would be immobilized with a dart rifle and then lethally injected or lethally removed via firearm. This would occur minimally and could occur in wilderness in the park. For animals suspected of having chronic wasting disease, carcasses would be removed if possible, sampled, and disposed of. Because under current management practices only a few elk per year would be removed from the park for this reason, and humans visiting wilderness would rarely detect this activity due to its short term and relatively quiet nature, effects on wilderness from the presence of staff in remote areas would be short term, local, minor, and adverse.

Monitoring

Monitoring elk and vegetation would continue to involve one or more aerial flights during the winter season and several days during the year people would be conducting ground surveys in wilderness.

In the winter, these surveys would occur in the wintering grounds in the eastern portion of the park; in the summer, they would occur in the alpine areas and the Kawuneeche Valley. For five days on the ground, people would be in undeveloped areas of the park for the ground surveys, with activities occurring during daylight hours. Aerial overflights would last one day each, with potential for at least one overflight to many overflights during the winter season. These short-term intrusions into the wilderness would limit outstanding opportunities for solitude on the days that overflights would occur, but only in portions of the park's wilderness, resulting in a short-term, regional, negligible-to-major, adverse effect on wilderness, depending on the distance from the helicopter. Helicopters would create far-reaching and enduring intrusion on wilderness.

Cumulative Impacts

The Park Omnibus Appropriations Act of 1998 banned the use of low-flying commercial air tours over the park, which had a long-term, regional, major, beneficial effect on wilderness through the prevention of low-level, reoccurring flights over the wilderness. In 1996, the Thompson Three arrival route to Denver International Airport caused 30 to 70 low-flying jets (as close as 15,400 feet in the air) to fly over portions of Rocky Mountain National Park's wilderness, an ongoing short-term, regional, major, adverse effect on wilderness, due to the frequency of occurrence.

The park's backcountry and wilderness plan benefits wilderness through establishing long term management goals for wilderness management, which, if absent, would be readily apparent to a visitor to wilderness, resulting in a long-term, regional, moderate benefit. Many ongoing park resource management plans involve potential short-term, adverse effects on wilderness, with frameworks for guiding actions that would protect natural resources. By protecting natural resources, these plans would also protect wilderness values, which would provide long-term, beneficial effects on wilderness. Fire and forest management activities, such as mechanical thinning, prescribed burns, and fire suppression, could potentially involve mechanized tool use in wilderness, which would affect wilderness noticeably but in small areas, a short-term, moderate, adverse effect. Removal of non-native fish would create visual and noise intrusions from work crews and affect natural conditions with associated tools in small areas (i.e., introducing piscicides into streams) that could in the short term adversely affect wilderness values on a measurable scale, creating minor-to-moderate, adverse effects on wilderness. Controlling exotic vegetation in the wilderness would cause short-term, minor, adverse effects on wilderness through adversely affecting resources, and therefore wilderness character, such as soils, water quality, and soundscape in a manner that would be apparent to observant visitors to wilderness. Construction of small fences would also temporarily affect wilderness through visual intrusion of work crews and fencing material, which alter wilderness character in a noticeable way, creating long term, moderate, adverse effects. Overall, these natural resource management actions would result in vegetation conditions closer to natural conditions than currently exist, which benefits wilderness character. Actions would be readily apparent, as the landscape would look more like it would have naturally, before exotic plant invasion and fire suppression. This would have a long term, regional, moderate, beneficial effect on wilderness.

Trail maintenance of existing trails would use hand tools where necessary in wilderness areas and would prevent erosion of trails, a long-term, minor, beneficial effect that would be detectable to human visitors if trails were not maintained. Noise generated by trail crews using tools and periodically blasting rock would generate short-term, localized, negligible to major impacts.

The general intrusion of humans into the wilderness, which can be in large numbers in some areas, would create a long-term, minor to moderate, adverse effect on wilderness character.

U.S. Forest Service wilderness areas that are adjacent to or near the park's wilderness benefit the park's wilderness by improving wilderness character and by protecting it from non-compatible land uses, a long term, minor, beneficial effect. However, some development pressure in other areas near the park is occurring, resulting in long-term, negligible-to-minor, adverse effects.

Nitrogen deposition on soils and in surface waters is occurring through atmospheric deposition of pollution from agricultural and populated areas to the east and south of the park. This has the potential to alter how wilderness appears in the park throughout the entire wilderness, but especially alpine areas by changing vegetation communities over time, including wildflowers, grasses and sedges. This would have a long-term, range-wide, moderate, adverse effect on wilderness, as it has the potential to noticeably change the appearance of vegetation within the park in a widespread manner.

The effects of these plans, projects, and actions, when combined, would have long-term, moderate, adverse effects, through combining the long-term, adverse effects of overflights and nitrogen deposition with the long-term, beneficial effects of resource management plans, nearby wilderness, and the ban on commercial air tours. Combined short-term effects of these plans, projects, and actions would be minor to moderate and adverse.

Alternative 1 would continue to have long-term, moderate, adverse effects on wilderness in localized areas of the elk primary winter range, primarily from noticeable degradation of willow and aspen communities. Short-term effects of Alternative 1 would be minor to moderate and adverse, primarily from monitoring elk by helicopter over wilderness areas. When the long-term effects of other plans, projects, and actions are combined with the overall effects of Alternative 1 on wilderness, cumulative long-term effects would be minor to moderate and adverse. Cumulative short-term effects would be minor to moderate and adverse.

Conclusion

Noticeable levels of vegetation degradation in willow and aspen communities in the elk primary winter range in the park would continue to have a long-term, local, moderate, adverse effect on wilderness because the degradation of vegetation would negatively affect wilderness values.

Limited fencing activities would only use hand tools in wilderness, resulting in local, negligible, adverse effects. Minimal redistribution techniques (i.e., pepper spray, mace, cracker rounds, rubber buckshot, and slingshot) would be used infrequently, if at all, in wilderness, resulting in short-term, local, minor, adverse effects on wilderness. The action of removing animals suspected of having chronic wasting disease would occur infrequently and potentially in wilderness under this alternative, a short-term, local, minor, adverse effect. Monitoring of elk and vegetation would include ground surveys and helicopter surveys that would occur at least one day per year, a short-term, regional, negligible-to-major, adverse effect on wilderness, depending on the distance from the helicopter.

Cumulative effects on wilderness would be long-term, minor to moderate, and adverse as well as short-term, minor to moderate, and adverse. Alternative 1 would contribute long-term, moderate, adverse effects and short-term, minor-to-moderate, and adverse effects on these overall cumulative effects.

Impairment of wilderness within the park would not occur under Alternative 1.

Alternative 2

The reduction of elk would, over time, result in changes to vegetation and ecosystems, resulting in the recovery of willow and aspen in the elk primary winter range within wilderness. Wilderness values would be noticeably improved through the recovery of vegetation in localized areas, resulting in a long-term, moderate, benefit to wilderness. Actions would be taken following the completion of a wilderness minimum requirements and minimum tool analysis.

The following actions taken within wilderness under Alternative 2 would occur to correct the results of past management actions, a provision in Director's Order 41, *Wilderness Preservation and Management*.

Lethal Removal

Lethally removing elk using primarily subsonic ammunition and suppressed-noise rifles, with some unsuppressed rifles to aid in redistribution, would be readily apparent in limited areas of the

wilderness, although no permanent effects would occur. However, because shooting typically is not allowed in national park wilderness, gunshots and the visual intrusion of staff with guns would affect wilderness character. Effects on wilderness would be moderate because shooting would not substantially alter the wilderness resource throughout the wilderness area, and, after a gun was fired, wilderness conditions would not have been substantially changed.

Darting with lethal injection would be used infrequently in wilderness in the park and does not introduce human-made noise, but the presence of humans would be slightly detectable, resulting in local, minor, adverse effects on wilderness.

Removal of carcasses (e.g., by foot, litter or sled [over frozen ground], pack animal, all-terrain-vehicle, winch, or truck) would create limited visual and noise intrusions into the wilderness from people, animals, and vehicles, resulting in short-term, local, minor, adverse effects on wilderness that could occur periodically throughout the park. If helicopters were used to remove carcasses from remote areas due to disease management concerns, effects on wilderness could occur anywhere within the elk range and would be negligible to major, and adverse, depending on the distance from the helicopter. The duration would be brief point-to-point flights.

Capture Facility

Erecting a capture facility with a temporary fence and corral in wilderness in the park would be a short-term, local, moderate, adverse effect on wilderness from visual and noise intrusions. The facility would only be present in wilderness for a few weeks at a time. Wilderness conditions would still prevail, and outstanding opportunities for solitude would still exist everywhere in the wilderness except within approximately a quarter mile of the capture facility, which would be readily apparent to visitors to wilderness in that area.

Access

Noise and other human intrusions into wilderness associated with access to the temporary capture facility, areas to be fenced, and other elk and vegetation management activities could involve both road and off-road vehicle use. Road use would have negligible effects on wilderness adjacent to roads because it would contribute no detectable addition to other road noise in the park, but off-road vehicle use in the wilderness would affect the primeval character of wilderness in the park, as it is not a noise associated with wilderness. While off-road vehicles would be used infrequently as a result of the minimum requirement analysis, effects on wilderness would be short term, local to range wide (depending upon the length of the route needed for access), minor to moderate, and adverse because effects would be noticeable to visitors to wilderness. If helicopters are used to remove carcasses from remote areas due to disease management concerns, there would be short-term, regional, moderate, adverse impacts in wilderness because this would be highly noticeable but likely only occur in limited areas at a time.

Vegetation Management

Installing fencing to protect aspen under Alternative 2 would introduce disturbances into wilderness, including the visual intrusion of human-made features in wilderness. Fences would be constructed in a phased approach and removed within 20 years of the implementation of this plan or earlier if communities are determined to be restored. If based on monitoring aspen fencing is necessary, then up to 160 acres of temporary fences would be installed in wilderness with up to 105 acres of aspen community on the elk winter range and 55 acres of aspen community on the summer range. However, fences would not be installed at one time but would

be installed commensurate with the changes in vegetation. Effects on wilderness from the presence of fences around aspen stands would be long term, local, moderate, and adverse, as they would be readily apparent but would be less noticeable due to being well dispersed and would only occur in 0.1% of the total park's wilderness. If helicopters were used to deliver fence material into remote areas of the park, the impact would be short-term, adverse, negligible to major, depending on the distance from the helicopter.

Prescribed fires could occur in wilderness under this alternative. Noise and human intrusions into wilderness in the elk primary winter and summer ranges during the course of the fires would be short term, local, moderate, and adverse, because impacts would be noticeably detectable from the fire, humans, and noise intrusions. Fire would restore a natural process into wilderness areas that would result in a long-term, moderate, local beneficial effect in areas treated.

Mechanical thinning activities could also occur in wilderness in the park, altering the viewshed with the presence of vehicles and work crews. These thinning activities, depending on the size of the treatment area, could continue for a week or more at a time in a given area. Chainsaws and brush cutters could create noise for hours at a given time. Effects of thinning on wilderness would be short term, local, moderate, and adverse in portions of the elk primary winter and summer ranges within wilderness, negatively affecting wilderness character at a noticeable level. These short-term effects could occur periodically for the life of the plan.

Redistribution Techniques

Redistribution techniques would occur at the same level of intensity as under Alternative 1 but would occur more frequently.

Herding with trained dogs would have short-term, localized, minor, adverse effects in wilderness in the elk primary winter and summer ranges because dogs are not allowed in park wilderness areas except for rescues or specialized research activities and would, therefore, have visual and noise impacts on wilderness. Their presence would be detectable, but would not alter the condition of the wilderness.

Noise from herding elk by people using noisemakers (i.e., pyrotechnic streamers, whistles), horses, and yelling could result in short-term, moderate, adverse effects, as the visual and noise intrusions would be rather noticeable and would affect solitude in the park. Horses would not be used above timberline; therefore, there would be no additional effect on wilderness from their use, as they are currently allowed in certain areas of wilderness.

If helicopters are used as an adaptive management tool they would have short-term, regional, moderate, adverse impacts in wilderness because this would be highly noticeable but likely only occur in limited areas at a time.

Aggressive or Injured Animals

Effects on wilderness would be the same as described for Alternative 1.

Monitoring

Because monitoring under Alternative 2 would be more frequent than what currently occurs. The short-term intrusions into the wilderness would limit outstanding opportunities for solitude on the days that overflights would occur, but only in portions of the park's wilderness, resulting in a short-term, regional, negligible-to-major, adverse effect on wilderness.

Research Activities

A research study evaluating procedures for a live test for chronic wasting disease in elk and efficacy of a fertility control agent would be conducted in coordination with elk management activities in the first three years of the plan. Effects on wilderness from the capture or darting, anesthetizing, and handling of elk would be the same as those described above for lethal control activities involving darting and access into wilderness.

Elk behavior of those subject to the fertility control study would not be altered by fertility treatments; therefore, this would have no observable effect on wilderness. However, the tagging and/or collaring of elk subject to the research study and use of a chemical that results in disruption of the natural functioning of elk (i.e. pregnancy) would affect wilderness values by creating visual intrusions that would be slight and disrupt natural biological processes while the study was occurring. The effects on wilderness from research activities would be short term, range wide, negligible to minor, and adverse.

Cumulative Impacts

Effects of other plans, projects, and actions on wilderness would be the same as described for Alternative 1: long term, moderate, and adverse as well as short term, minor to moderate, and adverse. Alternative 2's contribution to cumulative effects would be long term, moderate, and beneficial from returning to more natural conditions and short-term, moderate, and adverse from using helicopters and off-road vehicles for access, shooting elk by park staff, and constructing temporary fencing around aspen stands. Therefore, long-term, cumulative effects would be minor to moderate and adverse. Short-term, cumulative effects would be moderate and adverse.

Conclusion

The reduction of elk would, over time, result in changes to vegetation and ecosystems, resulting in the recovery of willow and aspen in the elk primary winter range within wilderness, representing more natural conditions. Wilderness values would be noticeably improved through the recovery of vegetation in localized areas, resulting in a long-term, moderate, benefit to wilderness.

Lethally removing elk using suppressed-noise and unsuppressed weapons would affect the primeval character of wilderness and introduce human-caused noise, resulting (even though from brief moments) in short term, local, negligible-to-major, adverse effects, depending on the distance from the noise source. Darting for lethal reduction or research activities would be used infrequently in wilderness and would be almost undetectable, resulting in local, minor, adverse effects on wilderness. Carcass removal would create limited intrusions from human voices, animals, and vehicle use, resulting in short term, local, minor, adverse effects on wilderness. Erecting a temporary capture facility for lethal reduction activities with a fence and corral would be a short-term, local, moderate, adverse effect on wilderness. Effects of accessing wilderness for management, monitoring, and research activities would be short-term, local, minor to moderate, and adverse. Effects on wilderness from installing fencing and the presence of fences around aspen would be long term, local, moderate, and adverse, as fences would be removed within 20 years of the implementation of this plan. Prescribed fires would have short-term, local, moderate, adverse effects on wilderness; mechanical thinning would have short-term, local, moderate, adverse effects in wilderness. Fire would restore a natural process into wilderness areas that would result in a long-term, moderate, local beneficial effect in areas treated.

Use of helicopters for various activities (e.g., fencing and monitoring or if necessary, carcass removal and herding) would have short-term, range-wide to regional, negligible-to-major, adverse effects on wilderness, depending on the distance from the helicopter. Helicopters would create far-reaching and enduring intrusions on wilderness.

Effects of redistribution techniques would be short term, local, minor, and adverse.

Herding with trained dogs, noisemakers, and horses would result in short-term, local, adverse effects that would vary from minor to moderate in intensity, as noise intrusions would be rather noticeable and would affect solitude in the park.

Effects on wilderness from the action of removing animals suspected of having chronic wasting disease would be the same as for Alternative 1: short term, local, minor, and adverse.

The reduction of elk would, over time, result in changes to vegetation and ecosystems, resulting in the recovery of willow and aspen in the elk primary winter range within wilderness, a long-term, moderate benefit to wilderness.

The tagging or marking of study elk and disruption of natural biological processes in a small number of elk treated with a fertility control agent would negatively affect wilderness values; these effects on wilderness would be short-term, range wide, negligible to minor, and adverse.

Cumulative effects on wilderness would be long term, minor to moderate, and adverse as well as short term, moderate, and adverse. Alternative 2 would contribute long-term, moderate, beneficial effects and short-term, moderate, adverse effects on these overall cumulative effects.

Impairment of wilderness within the park would not occur under Alternative 2.

Alternative 3

The reduction of elk under Alternative 3 would cause similar beneficial effects on wilderness as those described in Alternative 2, although the elk population would not be reduced as much in the park.

The following actions taken within wilderness under Alternative 3- would occur for the purposes of correcting the results of past management actions, a provision in Director's Order 41, *Wilderness Preservation and Management*.

Lethal Removal

Effects from lethal elk removal using subsonic suppressed-noise and unsuppressed weapons would have the same effect as described for Alternative 2 but would remain at a constant annual level of intensity throughout the plan. However, suppressed-noise weapons would be used less frequently, as lethal removal levels would be lower.

Darting with lethal injection would have the same effects on wilderness as described for Alternative 2. Removal of carcasses would have the same effects on wilderness as described for Alternative 2.

Access

Effects from accessing elk and vegetation management activities in wilderness would have the same effects as described for Alternative 2. Activities associated with installing fences would occur more frequently because more fence would be installed, but the intensity of impact would be the same during installation activity as for Alternative 2.

Vegetation Management

Fences would be installed over the 20 years of this plan to protect up to 600 acres of willow and aspen with 235 acres fenced in the primary summer range and 365 acres in the primary winter range of the elk population. Fencing around willows would be highly noticeable and would affect small to moderate sized areas of the elk primary summer and winter ranges, thereby substantially changing wilderness character at a local level. Because fencing would be more extensive (nearly four times the area of effect) and more concentrated in local areas under Alternative 3 than Alternative 2, effects on wilderness from the presence of fencing would also be greater: long term, local, major, and adverse.

Effects on wilderness from prescribed fire and mechanical thinning would be the similar to those described for Alternative 2, but would take place earlier due to the improved vegetation conditions within the fences.

Redistribution Techniques

Redistribution techniques under Alternative 3 would have the same intensity level as under Alternative 2, but would occur more frequently.

Effects of herding on wilderness would be the same as described in Alternative 2, but herding would occur more often.

Aggressive or Injured Animals

Effects of actions towards aggressive or injured animals would be the same as described for Alternatives 1 and 2.

Monitoring

Effects of monitoring would be the same as described for Alternative 2.

Research Activities

The use of darting to anesthetize animals and access into wilderness during research activities conducted in coordination with elk reduction activities would have the same effects on wilderness as described for Alternative 2.

Elk behavior of those subject to the fertility control study would not be altered by fertility treatments; therefore, this would have no observable effect on wilderness. However, the tagging and/or collaring of elk subject to the research study and use of a chemical that results in disruption of the natural functioning of elk (i.e. pregnancy) would affect wilderness values by creating visual intrusions that would be slight and disrupt natural biological processes in a small number of elk while the study was occurring; therefore, effects on wilderness would be short term, range wide, negligible to minor, and adverse.

Cumulative Impacts

Effects of other plans, projects, and actions on wilderness would be the same as described for Alternative 1: long term, moderate, and adverse as well as short term, minor to moderate, and adverse. Alternative 3's contribution to cumulative effects would be long term, moderate, and beneficial from a return to more natural conditions and short term, moderate to major, and

adverse from using helicopters and off-road vehicles for access, shooting elk by park staff, and constructing temporary fencing around aspen and willow stands in concentrated areas. Therefore, long-term cumulative effects would be minor to moderate and adverse. Short-term cumulative effects would be moderate to major and adverse.

Conclusion

Reduction of elk over time would result in more natural conditions for vegetation and ecosystems, a long-term, range-wide, moderate, benefit to wilderness. Fencing, prescribed fires, and mechanical thinning would, over time, result in more natural conditions than currently occur, with regard to vegetation and ecosystem processes. These changes as a result of management actions would have long-term, range-wide, moderate, beneficial effects on wilderness.

Lethally removing elk using suppressed-noise and unsuppressed weapons would affect the primeval character of wilderness and introduce human-caused noise the as in Alternative 2, resulting in short-term, local, negligible-to-major, adverse effects, depending on the distance from the noise source. Effects from darting for lethal reduction activities and research activities would be the same as in Alternative 2: local, minor, and adverse. Carcass removal would have the same effects as described for Alternative 2: short term, local, minor, and adverse. Effects of accessing the wilderness for management, monitoring, and research activities would be short-term, local, minor to moderate, and adverse.

Effects on wilderness from installing fencing and the presence of fences around aspen and willow would be long term, local, major, and adverse because the larger extent and grouping of fencing around willow would cause more of an intrusion into wilderness than under Alternative 2. As described for Alternative 2, prescribed fires would have short-term, local, moderate, adverse effects on wilderness; restoring natural processes into wilderness areas would result in a long-term, moderate, local beneficial effect in areas treated; mechanical thinning would have short-term, local, moderate, adverse effects in wilderness.

Use of helicopters for various activities (e.g., fencing or monitoring and if necessary, carcass removal and herding) would have effects as described for Alternative 2: short term, negligible-to-major, adverse effects on wilderness, depending on the distance from the helicopter. Helicopters would create far-reaching and enduring intrusions on wilderness.

Effects of redistribution techniques would be short term, local, minor, adverse.

Herding with trained dogs, noisemakers, and horses would have the same effects as described for Alternative 2: short-term, local, adverse effects that would vary from minor to moderate in intensity.

Effects on wilderness from the action of removing animals suspected of having chronic wasting disease would be the same as for Alternative 1: short term, local, minor, and adverse.

The tagging or marking of study elk and disruption of natural biological processes in a small number of elk treated with a fertility control agent would negatively affect wilderness values; these effects on wilderness would be short term, range wide, negligible to minor, and adverse.

Cumulative effects on wilderness would be long term, minor to moderate, and adverse as well as short term, moderate to major, and adverse. Alternative 3 would contribute long-term, moderate, beneficial effects and short-term, moderate-to-major, and adverse effects.

Impairment of wilderness within the park would not occur under Alternative 3.

Alternative 4

The reduction of elk under Alternative 4 would cause similar effects as those described in Alternative 3. The following actions taken within wilderness under Alternative 4 would occur for the purposes of correcting the results of past management actions, a provision in Director's Order 41, *Wilderness Preservation and Management*.

Lethal Removal

Effects from lethal removal using suppressed-noise and unsuppressed weapons would be the same as described for Alternative 3. Effects of darting activities would be the same as described for Alternative 3. Removal of carcasses would have the same effects on wilderness as described for Alternative 3.

Fertility Control

Targeted female elk would be injected with fertility treatments via dart rifles. Dart rifles are only heard when the gun is fired and only up to 70 yards away (Watry 2005d Fertility control activities where humans and human noise would intrude into the wilderness would have short-term, local, minor, adverse effects from the presence of park staff and vehicles.

Elk behavior would not be altered by fertility treatments; therefore, this would have no observable effect on wilderness. However, the tagging and/or collaring of injected elk and use of a chemical that results in disruption of the natural functioning of elk (i.e. pregnancy) would affect wilderness values by creating visual intrusions that would be slight and disrupt natural biological processes; therefore, effects on wilderness would be long term, range wide, minor, and adverse.

Access

Effects from accessing elk and vegetation management activities in wilderness would be same as described for Alternative 3.

Capture Facility

Erecting and using a temporary capture facility would have the same effects as described for Alternative 2.

Vegetation Management

Effects on wilderness from fencing would be the same as described for Alternative 3, however these effects would occur less frequently as fencing of montane riparian willow would occur only on the primary winter range. Effects on wilderness from prescribed fire and mechanical thinning would be the same as described for Alternative 3.

Redistribution Techniques

Redistribution techniques under Alternative 4 would have the same intensity level as under Alternative 3.

Effects of herding on wilderness would be the same as in Alternative 3.

Aggressive or Injured Animals

Effects of actions towards aggressive or injured animals would be the same as described for Alternatives 1 and 2.

Monitoring

Effects of monitoring would be the same as described for Alternative 2.

Research Activities

The use of darting to anesthetize animals and access into wilderness during research activities conducted in coordination with elk reduction activities would have similar effects on wilderness as described for Alternative 2. Tagging or marking of a small number of elk and the use of fertility control agent for research purposes would have negligible to minor adverse effects on wilderness.

Cumulative Impacts

Cumulative effects would be the same as described for Alternative 3. The effects of fertility control on wilderness would be long term, range wide, minor, and adverse, but would not alter the overall cumulative conclusion described in Alternative 2.

Conclusion

Reduction of elk over time would result in more natural conditions for vegetation and ecosystems, a long-term, range-wide, moderate, benefit to wilderness. Fencing, prescribed fires, and mechanical thinning would, over time, result in more natural conditions than currently occur, with regard to vegetation and ecosystem processes. These changes as a result of management actions would have long-term, range-wide, moderate, beneficial effects on wilderness.

Lethally removing elk using suppressed-noise and unsuppressed weapons would affect the primeval character of wilderness and introduce human-caused noise, resulting (even though from brief moments) in short term, local, negligible-to-major, adverse effects, depending on the distance from the noise source. Effects on wilderness from darting for lethal reduction actions and research activities would be the same as in Alternative 2: local, minor, and adverse. Carcass removal would have the same effects on wilderness as described for Alternative 2: short term, local, minor, and adverse). Erecting a temporary capture facility for lethal reduction actions with a fence and corral would have the same effects on wilderness as described for Alternative 2: short-term, local, moderate, and adverse.

Effects on wilderness from installing fencing and the presence of fences around aspen and willow would be long term, local, major, and adverse because of the large extent and grouping of fencing in the elk primary winter range.

Use of helicopters for various activities (e.g., fencing or monitoring, and if necessary, carcass removal or herding) would have the same effects as described for Alternative 3: short term, regional, negligible-to-major, adverse effects on wilderness, depending on the distance from the helicopter. The use of helicopters for fence installation would have this same range of effects although they would occur less frequently than Alternative 3. Helicopters would create far-reaching and enduring intrusions on wilderness.

As described for Alternative 2, prescribed fires would have short-term, local, moderate, adverse effects on wilderness; restoring natural processes into wilderness areas that would result in a long-term, moderate, local beneficial effect in areas treated; mechanical thinning would have short-term, local, moderate, adverse effects in wilderness.

Effects of redistribution techniques would be similar to Alternative 2: short term, local, minor, adverse, but would occur more frequently.

Herding with trained dogs, noisemakers, and horses would have the same effects as described for Alternative 2: short-term, local, adverse effects that would vary from minor to moderate in intensity.

Effects on wilderness from the action of removing animals suspected of having chronic wasting disease would be the same as for Alternative 1: short term, local, minor, adverse.

Effects of accessing the wilderness for management, monitoring, and research activities would be short-term, local, minor to moderate, and adverse. The tagging or marking of treated or study elk and disruption of natural biological processes would also negatively affect wilderness values; these effects on wilderness would be long term, range wide, minor, and adverse.

Cumulative effects on wilderness would be long term, minor to moderate, and adverse as well as short term, moderate to major, and adverse. Alternative 4 would contribute long-term, moderate, beneficial effects and short-term, moderate-to-major, adverse effects on these cumulative effects.

Impairment of wilderness within the park would not occur under Alternative 4.

Alternative 5

The reduction of elk under Alternative 5 would cause similar effects as those described in Alternative 2. The following actions taken within wilderness under Alternative 2 would occur to correct past mistakes, a provision in Director's Order 41, *Wilderness Preservation and Management*.

Wolves

The first phase of wolf release, would involve releasing a small number of wolves into the park. The process of wolf release would involve wolf pens, vehicles, and humans, all creating limited visual and noise intrusions into wilderness, which would have short-term, local, minor effects on wilderness. The wolves would wear global positioning system collars, which would allow for passive monitoring which would reduce intrusions into wilderness by helicopters or humans on foot for monitoring purposes.

After the first phase, the number of wolves in the park would be allowed to increase. The presence of wolves would improve wilderness character throughout the wolves' range by improving the experience for visitors to the wilderness who heard wolves howling and by restoring conditions to what naturally occurred in wilderness. Effects would be long term, park wide, and major beneficial, and would occur at least for the length of the plan.

Wolf monitoring could involve the use of helicopters to retrieve wolves if wolves approached the boundary of the park. This would result in a short-term, moderate, adverse effect on wilderness.

Lethal Removal

Effects from lethal removal using suppressed-noise and unsuppressed weapons would be similar to those described for Alternative 2, although somewhat less in the latter years.

Effects of darting activities would be the same as described for Alternative 2.

Removal of carcasses would have the same effects on wilderness as described for Alternative 2.

Access

Effects from accessing elk and vegetation management activities in wilderness would be the same as described for Alternative 2.

Capture Facility

Erecting and using a temporary capture facility would have the same effects as described for Alternative 2.

Vegetation Management

Effects on wilderness from fencing, prescribed fire, and mechanical thinning would be the same as described for Alternative 2.

Redistributive Techniques

Effects of herding on wilderness would be the same as in Alternative 2.

Aggressive or Injured Animals

Effects of actions towards aggressive or injured animals would be the same as described for Alternative 2.

Monitoring

Aside from wolf monitoring (described above), effects of monitoring would be the same as described for Alternative 2.

Research Activities

The use of darting to anesthetize animals and access into wilderness during research activities conducted in coordination with elk reduction activities would have similar effects on wilderness as described for Alternative 2. Tagging or marking elk and the use of fertility control agent for research purposes would have the same effect on wilderness as described in Alternative 2.

Cumulative Impacts

Cumulative effects would be the same as described for Alternative 2. The presence of wolves in wilderness would result in a minor-to-moderate, beneficial impact on wilderness. This would not alter the overall intensity of cumulative impacts as described for Alternative 2.

Conclusion

The reduction of elk would, over time, result in changes to vegetation and ecosystems, resulting in the recovery of willow and aspen in the elk primary winter range within wilderness. Wilderness values would be noticeably improved through the recovery of vegetation in localized areas, resulting in a long-term, moderate, benefit to wilderness. Effects of releasing wolves in wilderness would be long term, park wide, and major beneficial, and would occur at least for the length of the plan. The process of releasing wolves would cause noise and visual intrusions from humans, wolf pens, and vehicles, which would have short term, local, minor, adverse effects on wilderness.

Lethally removing elk using suppressed-noise and unsuppressed weapons would affect the primeval character of wilderness and introduce human-caused noise as in Alternative 2, resulting (even though from brief moments) in short term, local, negligible-to-major, adverse effects, depending on the distance from the noise source. Effects from darting for lethal reduction actions and research activities would be the same as in Alternative 2: local, negligible, and adverse. The effects of carcass removal activities would have the same effects as described for Alternative 2: short term, local, minor, and adverse. Effects of accessing the wilderness for management, monitoring, and research activities would be short-term, local, minor to moderate, and adverse. Erecting a temporary capture facility for lethal reduction actions with a fence and corral would have the same effects as described for Alternative 2: short term, local, moderate, and adverse.

Effects on wilderness from installing fences and the presence of fences around aspen would be the same as described for Alternative 2: long term, local, moderate, and adverse.

Use of helicopters for various activities (e.g., fencing or monitoring and if necessary, carcass removal) would have the same effects as described for Alternative 2: short term, regional, negligible-to-major, adverse effects on wilderness, depending on the distance from the helicopter. Helicopters would create far-reaching and enduring intrusions on wilderness.

As described for Alternative 2, prescribed fires would have short-term, local, moderate, adverse effects on wilderness; restoring natural processes into wilderness areas that would result in a long-term, moderate, local beneficial effect in areas treated; mechanical thinning would have short-term, local, moderate, adverse effects in wilderness.

Effects of redistribution techniques would be similar to Alternative 2: short term, local, minor, and adverse, but would occur more frequently.

Herding with trained dogs, noisemakers, and horses would have the same effects as described for Alternative 2: short-term, local, adverse effects that would vary from minor to moderate in intensity.

Effects on wilderness from actions of removing animals suspected of having chronic wasting disease would be somewhat less than for Alternative 1 because it is speculated that wolves would do some collection of chronic wasting disease-infected elk, thus reducing the numbers of carcasses to be removed through human activity: short term, local, negligible-to-minor, and adverse.

Effects from the reduction of elk, addition of fencing, prescribed fires, and mechanical thinning on natural conditions would be the same as described for Alternative 2: long term, range wide, minor, and beneficial.

The tagging or marking of study elk and disruption of natural biological processes for those treated with fertility control agent would negatively affect wilderness values; these would result in short term, range wide, negligible to minor, and adverse effects on wilderness. .

Cumulative effects on wilderness would be long term, minor to moderate, and adverse as well as short-term, moderate, and adverse. Alternative 5 would contribute long-term, moderate, beneficial effects and short-term, moderate, adverse effects on these cumulative effects.

Impairment of wilderness within the park would not occur under Alternative 5.

SOCIOECONOMICS

Summary of Regulations and Policies

The National Environmental Policy Act requires analysis of social and economic impacts resulting from proposed major federal actions in an environmental impact statement. From this requirement, the National Park Service has identified conditions that it wants to achieve in association with its management of national parks. These conditions are described in *Management Policies* (NPS 2006b).

Park activities often involve impacts that extend beyond park boundaries. In planning for the management of park resources, *Management Policies* (NPS 2006b) directs the National Park Service to "work cooperatively with others to anticipate, avoid, and resolve potential conflicts; protect park resources and values; provide for visitor enjoyment; and address mutual interests in the quality of life of community residents, including matters such as compatible economic development and resource and environmental protection (sec. 1.6)." Such local and regional collaboration might include other federal agencies, tribal, state, and local governments, neighboring landowners, and non-governmental organizations.

Furthermore, section 2.3.1.4 of *Management Policies* (NPS 2006b) requires that decisions documented in planning products, such as environmental analyses, will be based on current scientific understanding of park ecosystems, the cultural context, and the socioeconomic environment.

Methodology and Assumptions for Analyzing Impacts

Geographic Area Evaluated for Impacts

The description of the affected socioeconomic environment for this elk management plan and environmental impact statement requires a careful definition of the geographic area of effect. The primary impact area considered includes Rocky Mountain National Park and Estes Park, Colorado, with additional consideration of the Estes Valley. This area of effect was limited to these places because this is the region in which the concentrations of elk are highest, the presence of elk has the most influence on visitation in these areas, and the proposed actions would be confined to Rocky Mountain National Park. Changes in elk population or vegetation also could affect the socioeconomic circumstances of Larimer County. Effects of the alternatives on the businesses and economies of these locations were considered both quantitatively and qualitatively.

Perceptions of Rocky Mountain National Park's attractiveness as a place to visit could have implications for Grand Lake, the park's other gateway town, but these effects would be very small and possibly not measurable.

Issues

Socioeconomic issues identified during internal and public scoping related to elk and to management activities for elk and vegetation include

Both retail sales and the service industry in the Estes Valley depend on tourism.

Any action that affects socioeconomics includes effects on local employment, both permanent and seasonal.

Hunting is an economic contributor to the Estes Valley economy.

Property values and property damage are related to the actions of the elk population in town. Elk are currently affecting private property by consuming vegetation used for landscaping, damaging golf courses, causing automobile accidents, and reducing the fall foliage that many visitors come to Estes Park to view.

The overpopulation of elk has had an impact on local agricultural operations. The elk forage on both natural vegetation and supplementary feed intended for livestock.

Assessment Methods

Elk located in and adjacent to the park impact human behavior revolving around elk-related activities and economic conditions of government agencies, private homeowners, businesses, and ranchers. Tourists and other visitors, hunters, and residents of the areas surrounding the park (the Estes Valley and Grand Lake areas) are impacted by elk. The socioeconomic categories included in this section that may be affected by current elk and vegetation management or by a change in management include elk-related tourism and recreation draw, hunting activity, fiscal conditions of government entities, landscaping and property, agriculture, traffic accidents, human-elk interactions, and property values. The impacts on each of these categories under each management alternative, including current management, are discussed in detail below.

Socioeconomic impacts are based on the following analysis criteria: the target elk population for the area, the distribution of elk inside and outside the park on the east and the west sides, the behavior of the elk around humans and during mating season, and public perception of specific alternative details. For example, tourism and recreation draw may be enhanced by the possibility of seeing a wild elk, the possibility of which might decrease if elk numbers decrease. Hunting activity might be affected by the number and distribution of elk. In addition, public perception of elk management activities could impact a variety of socioeconomic categories. The public receives information on park management and activities from a variety of sources, including television, newspapers and magazines, the Internet, and word of mouth. The way a given activity is discussed and the way the public perceives it may impact the way they view the park and whether they want to visit it. For example, if the public does not like the idea of reducing the elk population through lethal reduction or fertility treatments, they may be less likely to visit the park. There is evidence that public perception does impact human behavior. Public perception of forest fires in Colorado negatively impacted overall visitation to Colorado in 2001 and 2002. Media coverage of the fires caused people to think that Colorado would be an unpleasant place to visit at that time and they changed their travel plans. Historical drops in visitation to the park have also been attributable to events such as gas shortages and war.

Many of the socioeconomic impact categories are related to one another and affect each other. When a category is impacted due to one of the analysis criterion, another category may also be impacted. For example, the number of elk may affect the tourist draw, and a change in the number of tourists drawn to the area would affect the fiscal conditions of the National Park Service, the Town of Estes Park, and the Estes Valley Recreation and Park District. A change in the number of elk may impact hunting activity, which would then affect fiscal conditions for the Colorado Division of Wildlife.

Changes in fiscal conditions of government entities due to changes in elk and vegetation management in the park focus on entities in the Estes Valley (the National Park Service, the

Colorado Division of Wildlife, the town of Estes Park, and the Estes Valley Recreation and Park District). It is assumed that, because of the smaller elk population compared to the east side of the park, any financial impacts on the Town of Grand Lake would be minimal, so its fiscal conditions are not analyzed. Changes in revenues are based on changes in visitation to the park and the Estes Valley and on changes in hunter activity. Changes in expenditures for the agencies would vary according to the specifics of each management alternative and are based on the professional judgments of agency managers.

Potential changes in hunting activity are based on estimates made by the Colorado Division of Wildlife. Economic impacts are calculated based on the change in hunter days from current conditions and the estimated spending of hunters near the east and west sides of the park.

Information Sources

Impacts on each category are based on a variety of information sources, including surveys, interviews, case studies, public scoping results, and professional judgment. Specific methodologies are discussed within category subsections.

Surveys

Rocky Mountain National Park visitors, Colorado residents, and the general public have been surveyed by various groups to determine their perceptions regarding the park, the number of elk in the area, elk management strategies, and wolf release. Survey studies cited in this socioeconomic impact analysis include a survey of Colorado-resident and nonresident park visitors and the general public completed in 2004 by Stewart, Fix, and Manfredo; a survey of Colorado-resident and nonresident park visitors completed in 1995 by Valdez; a survey of Colorado-resident and nonresident park visitors completed in 2000 by Cordova; and a survey of Estes Valley residents completed in 1985 by Berris. These surveys explored perceptions of specific management strategies, including wolf release (Manfredo 1994).

Surveys indicate that over 90% of visitors rate natural scenery, undeveloped vistas, and wildlife as important park features (NPS 1995, Cordova 2000b). Many visitors come to the park to view scenery and take pictures and generally enjoy the feel of a pristine environment. Visitors value the wildness of the park and the feel of the park as a natural environment.

One survey (Stewart et al. 2004) indicated that park visitors would be willing to accept a decrease in the number of elk in the park if natural conditions dictated, even if it meant decreased viewing opportunities. Respondents also agreed that it would be acceptable to reduce the size of the elk population to ensure aspen and willow regeneration. A moderate reduction in elk combined with intensive management of aspen and willow was rated acceptable by 70% to 80% of respondents. Respondents were mixed as to the acceptability of specific management strategies.

Surveys also highlighted the strong feelings that Estes Park and area residents have about elk and elk management (Berris 1987). Survey respondents stated that elk were an asset to the quality of life in the area due to their visual appeal, their reminder of nature, and the freedom inspired by the elk. Respondents also acknowledged some drawbacks to elk in populated areas, such as landscape and property damage and traffic congestion.

Stakeholder Interviews

Interviews were conducted with 29 stakeholders in 2003 and 2004, including 24 in Estes Park and five in Grand Lake. Stakeholders are individuals who represent broader groups affected by elk in general and by elk management in the park, and these interviews allowed an in-depth exploration of a range of issues. Stakeholders interviewed included NPS professionals, Estes Park managers, area residents, business owners and a rancher.

Stakeholders generally exhibited the belief that tourism is the driving economic force in the Estes Valley and that elk are an important part of the tourist draw. Visitors were ranked as the number one driver of the local employment base. Stakeholders indicated that elk are a positive draw for visitors and one of the top five draws to the area; however, they also believe there are too many elk in the impact area and wish to see a reduction in the elk population. They are worried about the loss of the uniqueness of the elk experience in the Estes Valley as pressure on elk to move to other areas increases due to excess numbers.

Stakeholders believe that the elk are an important part of local quality of life but perceive both beneficial and adverse effects from elk. More commonly cited negative aspects of the elk were traffic delays and accidents; increasing negative interactions between elk and residents and visitors; and landscaping, golf course, and other property damage.

The need for elk management was apparent to the stakeholders, but they were less certain about which management options would have beneficial impacts on the area. Activities such as fencing, lethal reduction, fertility control, and predator release received mixed reactions from stakeholders about the impacts on the community.

Due to the minimal impact of agriculture in the area and the small percentage of the economy related to agriculture, the analysis of agricultural impacts related to elk is based on an interview with Eric Adams of the MacGregor Ranch, and Mike Beck of the Switzer-Land Alpaca Farm.

Case Studies, Scientific Papers, and Professional Reports

Case studies and scientific papers were incorporated into the socioeconomic analysis. These studies focused on the effects of wolf release and other specific wildlife management strategies and on the effects of management on public perceptions. Specifically, the effects were examined of wolf release, hunting, lethal reduction, fertility treatments, and fencing at Yellowstone National Park (Wyoming and Montana) and Banff National Park in Canada. The effects of these activities on elk numbers, distribution, and behavior; on park visitation and recreational activities; and on area towns and local residents were examined.

Scientific studies incorporated into impact analysis included Kloppers, St. Clair and Hurd (2005) on the effects of redistribution techniques on elk; Loomis (2004) on the impact of elk on park visitation; Loomis and Caughlan (2004) on linking national park visitation to regional economic models; Wagner and Seal (1992) on the methodologies of managing overabundant wildlife populations; and Lubow et al. (2002) on the dynamics of elk within and adjacent to the park.

Also taken into account were reports and data from the U.S. Fish and Wildlife Service, the National Park Service, the Colorado Division of Wildlife, the Colorado Department of Transportation, and the Colorado Department of Local Affairs.

Professional Judgment

The professional judgments of the National Park Service, the Colorado Division of Wildlife, and Town of Estes Park managers were taken into account. These professionals were contacted and interviewed on numerous occasions to obtain relevant information. Discussions with these professionals were taken into account in the professional judgments of the EIS team.

Impact Threshold Definitions

Intensity of Impact

Negligible: Economic and socioeconomic conditions would not be affected, or effects would not be measurable.

Minor*:* The effect on economic and socioeconomic conditions would be small but measurable and would affect a small portion of the population. Few effects could be discerned outside the Estes Valley area.

Moderate*:* The effect on economic and socioeconomic conditions would be readily apparent and widespread in the vicinity of the Estes Valley, with effects being evident at the county level.

Major: The effect on economic and socioeconomic conditions would be readily apparent and would substantially change the economy or social services within the county area.

Type and Duration of Impact

Beneficial impact would be a positive contribution to the financial condition of a business, government entity, or private individual.

Adverse impact would be a negative contribution to the financial condition of a business, government entity, or private individual.

Duration: Short-term effects would end within three to five years after the implementation of the management action. Long-term effects would persist beyond the 20-year analysis period of this study.

Alternative 1

Elk Tourism and Recreation Draw

Tourism and recreation activities related to elk in the park focus on viewing and photographing elk in their natural environment, particularly in September and October during the elk mating season. Visitors travel to the park from other parts of Colorado and from outside the state to see elk in their natural habitat. The primary reason many visitors come to the park during the fall is to see the elk rut and to listen to elk bugling. Other activities that focus on elk are wildlife photography and educational and interpretive programs related to elk in the park.

Tourists that visit the park to experience the elk may also participate in other activities in the area, either in the park or in the Estes Valley. They may spend money on food, lodging, or other entertainment and recreational activities, and so the park and the Estes Valley benefit from the revenues generated from those tourists who come to see the elk. Changes in the way the elk are managed within the park could have an impact on those tourists and their activities in the area.

Under current management, no changes are expected in the number of elk as compared with current conditions. The elk population would fluctuate between 2,200 and 3,100 elk. No changes are expected in distribution or behavior of elk as compared with current conditions. An estimated 2.8 million people visited the park in 2004. In this alternative, elk would continue to account for an estimated 15% of total draw to the park and the Estes Valley (NPS 2005k). Elk-related visitation currently contributes an estimated $30 million in sales of goods and services, $10 million in personal income, and 750 jobs to the area (NPS 2005e).

Under current management, the vegetation in the park would continue to be threatened by elk herbivory. Although the park visitors feel that the current population level of elk combined with vegetation loss is unacceptable (Stewart et al. 2004), no change in visitation attributable to the elk would be expected, resulting in continued moderate-to-major, long-term, beneficial impacts on the region.

Hunting Activity and Experience

Hunting is an important recreational activity that occurs in the vicinity of the park. Elk hunting occurs on both the east and west sides of the park, with a greater number of hunters near the west side. The number of hunters in the Estes Park area has risen during recent years, making the Estes Valley an increasingly popular place to participate in the elk hunting experience. The increasing number of hunters in the area has not had a substantial impact on the number of elk harvested. The number of hunters near the west side has remained steady in recent years.

In addition to having cultural and social value, hunting has a notable economic impact on the area. Hunters spend money on permits, food, lodging, hunting gear, and equipment. Changes in the way the elk are managed within the park could have an impact on the hunting experience and on the number of hunters in areas adjacent to the park, such as Estes Park and Grand Lake.

There would be no change in number, distribution, or behavior of elk compared to current conditions. A steady 200 to 700 elk would be taken near the east side by approximately 2,000 hunters. About the same number of elk would be taken near the west side by approximately 5,000 hunters (CDOW 2005). Direct economic contribution from elk hunting would total about $0.8 million and $1.7 million per year for the east and west sides, respectively (BBC 2004).

Alternative 1 would continue to contribute a long-term, moderate, beneficial impact on hunting.

Fiscal Conditions of Governmental Entities

Government entities in the Estes Valley are impacted by elk and vegetation management in the park, as management affects the number of elk outside the park in Estes Valley. The presence of elk in these areas is a benefit to many of the agencies, but the agencies also incur costs related to elk activity. Many of these entities rely on elk-related visitation and activity (tourists and hunters) to bring in revenue but also realize expenses due to elk management and elk-related damage. Changes in the way the elk are managed within the park could have an impact on the revenues and expenditures of these government entities.

With no change in the number or distribution of elk in the park and the Estes Valley, there would be no change in public sector expenditures or revenues compared to current conditions. Fiscal conditions for the National Park Service, the Town of Estes Park, the Estes Valley Recreation and Park District, and the Colorado Division of Wildlife would be unchanged.

No change in visitation to the park is expected due to this alternative; therefore, NPS revenue directly related to elk would be similar to current conditions. The National Park Service collected about $6.5 million in revenue from entrance fees and the sale of long-term passes from 2004 to 2005. Elk make up 15% of visitor draw to the park each year; therefore, 15% of the NPS entrance fee revenue, or approximately $1 million, is due to elk. A small portion of the park budget (less than 1%, or less than $200,000) is currently related to elk and vegetation management, and this would continue under Alternative 1. Revenues related to elk would continue to be a moderate, long-term benefit to the park, and elk-related costs would be long term, minor, and adverse.

The Town of Estes Park collects most of its revenues from sales and use taxes. Revenues for the town were about $11 million in 2002. Expenditures in 2002 were about $7.5 million (Colorado Department of Local Affairs 2002). Elk account for an estimated 15% of Estes Park tax revenue, or about $1 million. The Town of Estes Park estimates that it spends a minimal amount each year to manage elk and repair elk-related damage to town property (Feagans 2005). This would continue to result in long-term, moderate, benefits from revenues and negligible, adverse effects from elk-related costs.

The Estes Valley Recreation and Park District derives most of its revenue from user fees at its recreational facilities and devotes nearly its entire budget to maintenance and operations. Over half of district revenue is generated from the 18-hole Estes Park golf course. Revenue for the district in 2004 was greater than $2.5 million, and expenditures were greater than $2.3 million. Elk account for a minimal portion of district revenues and expenditures. The Estes Valley Recreation and Park District spends about $13,000 per year on managing elk and repairing any damage they cause to district property (Gengler 2005). The district was not able to estimate what portion of their revenue was a direct result of elk. This would continue to result in negligible benefits and long-term, moderate, adverse impacts.

The Colorado Division of Wildlife generates most of its revenues through hunting and fishing licensing fees. Elk hunting licenses alone account for about 40% of the CDOW annual budget. A nonresident elk hunting license costs about $500, and a Colorado-resident elk hunting license costs $30 (CDOW n.d.). In 2003, total license revenue for Colorado was greater than $60 million. Most CDOW expenses revolve around wildlife habitat management, recreation and education. In 2003, CDOW expenditures on these activities were greater than $60 million. A large portion of CDOW costs in the game management units near the east and west sides of the park would be related to elk due to the number of elk and the amount of hunting in the area. Only a small portion of statewide costs are due to elk; however, the Colorado Division of Wildlife does pay some damage reimbursement to farmers and ranchers affected by wildlife, though damage reimbursement is not a significant factor for the division in this area due to lack of agricultural activity. The overall impacts on the Colorado Division of Wildlife would continue to be negligible to minor and adverse.

There would be a net, negligible, long-term, beneficial impact on fiscal conditions compared to current fiscal conditions as a result of Alternative 1.

Landscaping and Property Impacts

Costs associated with elk damage to public property have been covered in the "Fiscal Conditions of Government Entities" section. This category focuses on elk-related impacts on private property, including costs realized by private landowners and benefits realized by local landscaping companies. The analysis of costs and benefits related to landscaping and property impacts is based on interviews with local homeowners and landscaping companies. Many individuals noted damage to landscaping as a negative impact of elk.

Large numbers and high concentrations of elk in the park and the Estes Valley have an impact on vegetation outside of the park as well as inside. Elk browse on landscaping plants, grasses, and trees and can cause damage to property, such as fences, as they graze. Landscaping damage is not aesthetically pleasing to homeowners, and the costs of repairing damage are a negative side effect of having elk in the backyard. However, landscaping companies do benefit from the amount of work created as a result of elk damage to property.

The number and distribution of elk in the Estes Valley area would not change, and neither would the amount or distribution of landscaping or property damage, as compared with current conditions. Most landscaping impacts would continue to be felt by local homeowners. The costs incurred by homeowners as a result of elk damage would be approximately equal to the benefits seen by local landscaping companies. Landscaping companies supply new shrubs, plants, and flowers to homeowners, supply or install fences, and supply other landscaping needs. The current impact of elk on landscaping costs to private homeowners in Estes Park is estimated at $350,000 annually (Dudzinski 2003, Harvey Economics 2005). The net long-term impact of Alternative 1

would be a continued long-term, minor-to-moderate, adverse impact on landscaping and private property.

Agriculture

Agriculture accounts for a minimal portion of the economy in the Estes Valley. There is only one operating cattle ranch in the geographic area of analysis.

The number of elk and the distribution of elk would be unlikely to change; therefore, no change would be expected in agricultural impacts as compared to current conditions. The one ranch owner in the region experiences between $90,000 and $180,000 in lost revenue annually due to elk grazing. The ranch grazing plan accounts for 100 to 200 elk on the property, equaling 500 to 1,000 annual unit months of hay consumed by the elk. In addition to lost revenue due to elk grazing, the ranch incurs minimal costs due to elk damage, mostly related to damaged fencing (Adams 2003). There would continue to be a moderate, long-term, adverse impact for the ranch and on the agricultural environment.

Traffic Accidents and Congestion

Roadways in Estes Park are crowded with visitors driving to the park or to the Town of Estes Park. In 2004, the Colorado Department of Transportation counted six million vehicles at the intersection of two major highways in Estes Park (CDOT 2005). Elk often congregate in large groups near roadways within the park and in areas around and within the Town of Estes Park, especially during the fall mating season. Elk graze on grassy areas and wander across roads and, at times, walk along road shoulders. Elk on the roads can cause congestion or traffic jams, especially during the fall mating season, as drivers stop to watch elk or wait for them to cross the road. The combination of elk and cars on roadways can also cause minor or severe traffic accidents. Accidents can result from hitting an unseen elk on roadways, from hitting an elk that has darted into the road, from a driver trying to avoid an elk, or from a driver watching elk and not paying attention to the road. Elk-automobile accidents and other elk-related accidents occur in the park and in other areas in the Estes Valley. Stakeholders indicated that elk-related traffic congestion and traffic accidents were a concern.

The Colorado Department of Transportation tracks traffic accidents in Estes Park and the Estes Valley and has information on the number of accidents involving wild animals in general but does not separate out accidents that involve elk specifically. In general, traffic accidents involving wild animals have been on the rise, both in absolute number and in proportion of the total number of accidents in town.

The number of elk and distribution in the park and in the Estes Valley would be unlikely to change. Visitation to the park is not expected to change as a result of current elk management. Therefore, any change in traffic congestion or numbers of traffic accidents involving wild animals would not likely be the result of elk-related accidents. Elk would continue to make a minor-to-moderate, adverse, seasonal (fall mating season) contribution to congestion and traffic accidents in the park and Estes Park.

Currently, up to an estimated 30 to 35 accidents per year involve elk and are repaired by body shops in the area (CDOT 2004, Thoms 2004). These accidents cost drivers an estimated $75,000 annually but benefit auto body shops in the area by approximately the same amount (Rocky Mountain Insurance Information Association 2005, Thoms 2004). There are three auto body shops in Estes Park that share the work from elk-related damage. Tourists generate most auto repair work and a small portion of body work for auto body shops in Estes Park (Thoms 2004).

This alternative would have a minor-to-moderate, beneficial, long-term effect on body shops, as they would continue to repair damages from elk-related accidents, and a minor, long-term, adverse impact on visitors compared to current conditions.

Property Values

Elk have direct and indirect impacts on property values in the Estes Valley. As mentioned above, elk have a beneficial impact on the quality of life in the area, which has an impact on property values. The benefits residents receive as a result of elk depend, in part, on the number of elk in the area. If there are too few elk, residents would not readily know they are there; if there are too many elk, there would be landscaping damage, traffic issues, and the possibility of negative elk-human interactions.

More important to property values than the addition to quality of life is the impact that elk have on visitor draw to the area. Tourism and recreation account for more than 40% of the economy in the Estes Valley, and elk are a large part of the draw to the area. Stakeholders indicated that visitors are vitally important to the local economy. A strong economy would affect the desire of people to move into the area and would have a positive impact on property values. Any change in tourist visitation to the area that has a significant impact on the local economy may have an impact on property values.

Current property values are relatively high in the Estes Valley and have risen rapidly since 1990. Since distribution and numbers of elk would be unlikely to change, and no change is expected in visitation to the area, no change in property values as a result of elk would be expected from current conditions. Elk would continue to contribute a net minor-to-moderate benefit to the quality of life of Estes Valley residents and would continue to contribute to the local economy through attraction of visitors. Property values would likely experience a negligible, long-term impact compared to current conditions.

Cumulative Impacts

The Estes Valley area is a growing community that is sustained in large part by its attractive mountain setting and its proximity to Rocky Mountain National Park. Population grew rapidly from the 1960s through the 2000, growing faster than the state. In the 1990s alone, the Estes Valley grew 47.1% compared to the state, which grew at 24.4%. The Estes Valley population is forecast to grow 29.4% by 2010. Tourism accounts for much of this growth; however, the socioeconomic environment is also changing as more retirees move to the community (Larimer County Planning Division 2005).

Tourism and visits to Rocky Mountain National Park are a substantial contributor to the Estes Valley economy. Since 1984, when visitor counting procedures improved, the number of visitors has grown fairly steadily from 2.2 million to 3.2 million. Although, elk contribute to the draw of the park, visitors come to the park for a variety of other reasons. Visitors also have many reasons for visiting the Town of Estes Park and other areas in the Estes Valley, including culture and entertainment, shopping, recreation, and dining.

The summer season is the peak for visitation to the park and to the Estes Valley. However, over the past 20 years, there has been an increased importance of the non-summer tourist season. This is evidenced by the declining percentage of visitors coming from June through September. In 1982 and 1983 , visits during this time period were over 78%, but fell fairly steadily to approximately 70% in 2000 through 2004 (NPS 2005f). Numerous special events outside the national park provide a sustained attraction to the area and contribute to both summer and non-

summer visitation. These include activities such as the Wool Market (mid-June, 10,000 attendees), the Rooftop Rodeo (mid-July, 10,000 attendees), the Scottish Festival (early September, 65,000 attendees), the Elk Festival (end of September, 5,000 attendees), and the Christmas Parade (late November, 22,000 attendees). The attractions of the park and the Estes Valley cumulatively have a major, long-term, beneficial effect on the Estes Valley.

Sales tax revenues have grown steadily and are expected to grow at a rate of 4% to 5% per year for the next several years (RRC 2005). However, with rapid population growth and an increasing number of retirees, tourism has declined slightly in its relative importance to the economic base of Estes Park. To continue long-term stabilization and diversification of the Estes Valley economy, revitalization of the Estes Park Urban Renewal District has taken place and shopping and retail opportunities have been broadened. The Estes Valley Comprehensive plan intends to continue to broaden the job base through increasing industrial jobs (Larimer County Planning Division 2005). These actions and growth from sectors other than tourism are expected to contribute to long-term, moderate-to-major, cumulative benefits.

Growth in the Estes Valley would be expected to increase problems associated with more people and the relatively confined geography of the valley. Increases would be expected in encroachments of development on open spaces, adverse interactions with wildlife, and traffic congestion and accidents. Long-term growth within the Estes Valley would be expected to result in long-term, minor-to-moderate, adverse, cumulative, socioeconomic effects.

Alternative 1 would continue to provide benefits because the distribution and numbers of elk would not be likely to change, and no change would result in the net positive contribution of elk to the socioeconomic environment. Elk would continue to attract a substantial number of visitors and hunters to the area who would spend money both inside and outside the park. Elk-related revenue and expenditures for government entities would be similar to current conditions. The beneficial effects of Alternative 1 would continue to contribute to the long-term, moderate-to-major, cumulative benefits within the socioeconomic environment.

Under Alternative 1, elk would continue to damage landscaping and property in the Estes Valley, adversely impact agricultural revenue in the area, and cause traffic congestion and accidents in the park and in town. Potential for negative elk-human interaction would continue, and elk would continue to have direct and indirect impacts on property values. The adverse impacts of Alternative 1 would continue to contribute to but not increase the long-term, minor-to-moderate, cumulative, adverse impacts that exist within the socioeconomic environment.

Conclusion

Under current management practices, the vegetation in the park would continue to be threatened by elk herbivory. Although park visitors feel that the current population level of elk combined with vegetation loss is unacceptable (Stewart et al. 2004), no change in visitation attributable to the elk would be expected, resulting in continued moderate-to-major, long-term, beneficial impact in the region.

Alternative 1 would continue to contribute a long-term, moderate, beneficial impact from its contribution to hunting. Revenues related to elk would continue to be a moderate, long-term benefit to Rocky Mountain National Park, and elk-related costs would be long-term, minor, and adverse. The Town of Estes Park would continue to receive long-term, moderate benefits from elk-related revenues and negligible, adverse effects from costs. The Estes Valley Recreation and Park District would receive negligible benefits from elk-related revenues, but would continue to experience long-term, moderate, adverse effects from costs. The overall impacts on the Colorado Division of Wildlife would continue to be negligible to minor and adverse. There would be a

continued long-term, minor-to-moderate, adverse impact on landscaping and private property. There would continue to be a moderate, long-term, adverse impact on the ranching and agricultural community. Elk would continue to make a minor-to-moderate, seasonal (fall mating season) contribution to congestion and traffic accidents in the park and Estes Park. This alternative would have a minor to moderate beneficial, long-term effect on body shops, as they would continue to repair damages from elk-related accidents. Elk would continue to contribute a net minor-to-moderate benefit to the quality of life of Estes Valley residents. Property values would likely experience a negligible, long-term impact.

The beneficial effects of Alternative 1 would continue to contribute to the long-term moderate to major cumulative benefits within the socioeconomic environment. The adverse impacts of Alternative 1 would continue to contribute to, but not increase the long-term, minor to moderate cumulative adverse impacts that exist within the socioeconomic environment.

Alternative 2

Elk Tourism and Recreation Draw

Under this alternative, the target elk population would be at the low end of the natural range of variation, fluctuating between 1,200 and 1,700 animals. Elk distribution would be similar to that under current conditions, but there would be more elk outside the park near the west side during hunting season as a result of lethal reduction and redistribution techniques. Elk behavior would be similar to that under current conditions, but elk could be slightly more skittish or have a "wilder" feel to them as a result of lethal reduction and redistribution techniques. Visitors' likelihood of experiencing elk would be reduced slightly with a smaller number of elk, but visitor draw would not be affected , as bugling and rutting in the fall would occur in the same places as they currently do. Most visitors would be willing to accept a decrease in the number of elk if natural conditions dictated a decrease was necessary, even if it meant decreased viewing opportunities (Stewart et al. 2004).

Public perception would be a concern in the initial phase of this alternative. The most intensive lethal reduction would occur during the first four years of the program, during which 200 to 700 elk would be lethally removed per year. After that, lethal reduction would occur at a reduced rate of 25 to 150 elk per year for the next 16 years. Using government employees to lethally remove elk was rated as acceptable to approximately half of survey respondents (Stewart et al. 2004). However, there is concern that negative perception of lethal reduction efforts may affect visitation in the short term due to media coverage of the activity. Lethal removal of elk in the park could be a controversial issue for some groups of people. One of the major reasons for discontinuing the bison lethal reduction program at Yellowstone in 1968 was the public outcry after media coverage by the national news (Smith and White 2005). In addition to concerns related to the perception of lethal reduction, redistribution techniques, such as herding and aversive conditioning, are not highly acceptable to the public (Stewart et al. 2004, Kloppers et al. 2005).

Concerns about negative public perception could be addressed with public education of the program details. A lethal reduction program may be more acceptable to the public if they understand the impacts of the current number of elk, the reasons for reducing elk numbers, and program details such as the short-term timeline of intensive lethal reduction and the humane treatment of the elk. There would be a minor-to-moderate, adverse, short-term effect on visitation as a result of lethal reduction efforts. Decreased visitation would have a minor-to-moderate, adverse, short-term effect on area sales and local income.

It is estimated that there would be a 5% decrease in visitation during the first four years of the lethal reduction program due to negative public perception of lethal reduction activities. The 5% reduction in visitors would result in a $1.5 million loss in sales, $0.5 million loss in personal income to employees, and a loss of about 35 jobs. These losses are based on a 5% decrease in current condition sales, income, and number of jobs directly related to elk. Impacts would be felt within Rocky Mountain National Park as well as in Estes Park and other areas surrounding the park.

A small amount of fencing would be installed around 160 acres of aspen stands on the primary winter and summer ranges as part of this alternative. Fences would be temporary, and would be designed to allow access to other species and with gates to allow visitor access to enclosed areas. Efforts would be made to minimize the visual impact of fences through design and selection of materials. Vegetation would improve as a result of the reduction in the number of elk and the fencing. Survey respondents and stakeholders indicated that a balance between elk and vegetation was an important goal and that at least some aspen and willow management was needed. Vegetation alone is not a large draw to the park, and vegetation improvement in some areas would not be likely to have a substantial impact on visitation. Vegetation improvement and fencing would have a negligible-to-minor, long-term benefit on visitation.

Research activities to evaluate procedures for testing live elk for chronic wasting disease and effectiveness of a fertility control agent during the first three years of plan implementation may cause some concern due to public perception of fertility control in a free ranging wildlife. Short- and long-term contraception were acceptable to approximately half of survey respondents (Stewart et al. 2004) and some portion of the public would support research on a non-lethal population control method. The number of female elk that would receive the fertility control treatment as part of the study would be small, as not more than 120 female elk would be subject to study and at least half would be treated with a fertility control agent. In addition, the public in general would support efforts to enhance the ability to test for chronic wasting disease in live elk as opposed to current methods of testing heads in deceased elk. Overall, there would be no effect on visitation to the area or park as a result of research activities.

Alternative 2 would be expected to create a net short-term, minor-to-moderate, adverse effects on tourism and recreation draw as a result of public perception of lethal reduction and redistribution techniques, but a negligible, long-term, adverse effect on tourism and recreation would be expected.

Hunting Activity and Experience

Elk distribution would be similar to that under current conditions, but there would be more elk outside of the west side of the park during hunting season as a result of lethal reduction and redistribution techniques inside the park. Elk hunting near the west side of the park would increase in the short-term due to the number of elk driven out of the park during hunting season. Redistribution techniques would push elk out of the park, but the increase in the number of elk near the west side would only occur in the short-term, since elk numbers would be greatly reduced after the initial phase of lethal reduction. Currently there is a limit on hunting licenses sold in GMUs on the west of the park, however license numbers generally are kept high in order to manage elk within the objectives established by CDOW. With increases in elk outside of the park, there likely would be a short term increase in hunter interest in areas immediately west of the park including a short term increase in licenses sold. (Leslie 2005). It is estimated that there is potential for a 5% increase in hunter days near the west side of the park. This increase would result in an additional $85,750 of direct contribution to the local economy from hunters near the west side of the park, based on a 5% increase in west side hunter-based revenue. There would

therefore be a moderate, short-term, beneficial impact on hunters near the west side of the park and the Grand Lake community.

Decreased numbers of elk on the east side of the park would result in a short- and long-term decrease in the number of hunting licenses available (Leslie 2005). This would result in a slight decline in elk harvest in the east side of the park in the short and long terms, which would have a minor net adverse effect on the east side. It is estimated that there would be potential for a 2% to 3% decrease in the number of hunter days near the east side, which would mean a loss of between $16,000 and $24,000 of direct economic contribution to the local economy due to decreased elk hunting near the east side. These numbers are based on a decrease of 2% to 3% of hunter-based revenue near the east side. There would be a minor, long-term, adverse impact on hunters and the Estes Park community near the east side of the park.

In the short term, hunting near the east side of the park would be adversely affected from a reduction of elk and more skittish elk, and hunting near the west side would be positively affected as elk would be pushed out of the park from redistribution. Short term, there would be a net negligible-to-minor impact on hunting activity as a result of this alternative. In the long-term, hunting activity near the east side would continue at a decreased level and hunting near the west side would probably continue at original levels, since there would be fewer elk in the area. There would be a net negligible-to-minor, adverse, long-term impact on hunting.

Elk that are subject to the fertility control agent and to immobilization drugs to test for chronic wasting disease as part of the three-year research study may cross the park boundary and be subject to hunting. Treated elk would receive long-term mark that warns individuals not to consume the meat if the elk was killed before the required withdrawal period had passed for a regulatory approved fertility control agent or immobilization drug. Since capture of animals would happen in the winter, this would only potentially affect late-season hunters in January and February of the initial year of study. Because of the small number of female elk to be treated, the short timeframe of the study, and the limited exposure of hunters to study elk, there would be no effect on hunting activity in the area.

Fiscal Conditions of Governmental Entities

The National Park Service is expected to see a minor-to-moderate, short-term drop of approximately $50,000 in annual elk-related entrance fee revenue due to an estimated 5% decrease in visitation with Alternative 2. The National Park Service would also experience reduced revenue from its concessionaire contracts, as a reduced number of visitors would also spend less on concessions. In addition, the National Park Service would experience a moderate, short-term increase in costs and a minor, long-term increase in costs due to the activities of lethal reduction, redistribution, and fencing.

The Town of Estes Park would experience a minor-to-moderate, short-term adverse impact on revenue due to the decrease in park visitors. The decrease in visitors to the Estes Valley would result in a loss of about $50,000 in tax revenue for the town, a 5% decrease in current elk-related taxes. Beneficial impacts due to reduced costs related to elk management and damage would be negligible and long-term.

The Estes Valley Recreation and Park District would see a minor, beneficial impact from decreases in costs in the short- and long-terms due to the reduced number of elk. Costs to the district as a result of elk related management and damage repair would decrease by about $3,000, based on the assumption that elk-related costs would decrease by half the percentage decrease of elk. The Estes Valley Recreation and Park District would also experience a negligible, adverse impact from decreases in revenue in the short term due to decreased visitation to the area.

The Colorado Division of Wildlife would see costs and revenues similar to those under current conditions. The decrease in hunting activity near the east side of the park would be offset by increased hunting activity near the west side of the park, so total costs and revenues would not be significantly affected. Long-term, beneficial and adverse impacts from changes in fiscal conditions for the Colorado Division of Wildlife would be negligible.

Changes in long-term visitation to Rocky Mountain National Park and the Estes Valley would be negligible; therefore, long-term fiscal impacts would be negligible for all jurisdictions.

Landscaping and Property

With a decrease in the number of elk inside and outside the park, local landowners would see minor-to-moderate, short- and long-term decreases in landscaping and property damage costs. In the short-term, the number of elk in Estes Park would be reduced by about 30%; in the long-term the elk population would be reduced by about 45%. Fewer elk in the Estes Valley would mean less elk browsing and grazing, which would result in a decrease in the amount of elk-related damage. Conditions for homeowners' landscaping and property would improve, but some elk-related damage would still occur, since elk would still be present. Landscaping costs would decrease by half the percentage decrease of elk, resulting in about $80,000 in decreased annual damage costs in the short-term and long-term for homeowners.

Landscaping businesses would experience minor-to-moderate, short- and long-term decreases in revenue due to a decrease in elk related damage, with decreased annual revenue of up to $80,000. The amount of fencing installed to stop elk herbivory would decrease, as would the portion of plant sales due to elk browse. The loss of revenue would be slightly offset by homeowners buying more annuals, which they do not buy now due to the high numbers of elk browsing in town.

Agriculture

There would be fewer elk in the Estes Valley area as compared to current conditions, due to lethal reduction activity. With fewer elk on the property, the rancher would be able to graze more cattle on the ranch. Management activities are assumed to affect elk in direct proportion to their current distribution. It is assumed that the percentage decrease of elk in the Estes Valley would be equal to the percentage decrease of elk on the ranch property. This alternative would result in a decrease of between 46 to 92 elk on the ranch property and the possibility of increasing cattle by 23 to 46 animals. The increased cattle would increase ranch revenue by $41,000 to $82,000. With fewer elk in the Estes Valley and on the ranch property, the rancher would likely see a minor decrease in costs related to elk damage. Hunting is offered on the ranch, and fewer elk may reduce revenues received from hunters. This would off-set decreases in elk damage costs somewhat.

There may be a reduction in elk use on agricultural lands in the Kawuneeche Valley with a reduction of the elk population in the park. While damage claims on the west side are minimal there are many practices in place to reduce elk impacts on adjacent agricultural lands on the west side.

The rancher would likely experience minor-to-moderate, short- and long-term benefits from a reduced number of elk grazing on his property.

Traffic Accidents and Congestion

A decrease in the number of elk in the park and in the Estes Park area would mean a decreased number of elk in roadways and on road shoulders and would lessen the possibility of elk-related traffic congestion and traffic accidents. In the short-term, the number of elk in Estes Park would be reduced by about 30%; in the long-term, the elk population would be reduced by about 45%. In addition to fewer elk, there would also be 5% fewer visitors, in the short-term, to the park and to the surrounding areas to view the elk, resulting in a decrease of accidents and congestion. The reduction in the number of elk and in the number of visitors to the area would have a minor, short- and long-term benefit to traffic congestion.

The number of traffic accidents in the area would be reduced as a result of the smaller number of elk in the area. The reduction of elk as a result of lethal reduction in this alternative would lead to approximately $17,000 in decreased revenues for Estes Park auto body shops, based on the assumption that body shop revenue would drop by half the percentage decrease in the number of elk. There would be a minor, short- and long-term adverse impact on Estes Park body shops. The net effect of a reduced number of elk in the Estes Valley on elk-related traffic accidents would be negligible to minor and beneficial in the short and long term.

Property Values

There would be a decreased number of elk in the Estes Valley as a result of lethal reduction activity, but the presence of elk would probably be sufficient to maintain their contribution to the quality of life in the Estes Valley. With fewer elk in the area, there would be a lower amount of landscape damage, fewer elk-related traffic accidents and fewer possibilities for negative elk-human interactions, each of which would not likely impact property values but affects the overall quality of life. Visitation to the area would be decreased, but only in the short term. This short-term decrease would not have enough impact on the local economy to affect property values. These alternatives would result in minor, short- and long-term benefits to property values.

Cumulative Impacts

The existing cumulative socioeconomic impacts would continue as described in Alternative 1. The attractions of the park and the Estes Valley cumulatively would continue to have a major, long-term, beneficial effect on the Estes Valley. Growth from sectors other than tourism would be expected to continue to contribute to long-term, moderate-to-major, cumulative benefits, and other effects from long-term growth within the Estes Valley would be expected to result in long-term, minor-to-moderate, adverse, cumulative, socioeconomic effects.

Alternative 2 would reduce the number of elk as a result of lethal reduction activity; the intrinsic value of the elk experience would likely remain unchanged. In the short term, visitation would decrease, but long-term visitation would not be affected and adverse impacts would be negligible. Hunting activity would decrease near the east side of the park, but would increase near the west side. The National Park Service, Estes Park, and the Estes Valley Recreation and Park District would experience a short-term loss of revenue, but long-term fiscal impacts would be negligible for all government entities.

In the short and long-term, there would be a minor-to-moderate benefit to homeowners and loss to landscaping companies from a decrease in elk-related damage. Agriculture would experience minor-to-moderate, short- and long-term benefits from the reduced number of elk. Traffic congestion would decrease in the short-term, but there would be negligible long-term impacts.

Elk-related traffic accidents would decrease in the short and long term. There would be minor, short- and long-term benefits to property values.

The short-term, minor-to-moderate and long-term, negligible, adverse effects on tourism and recreation draw resulting from Alternative 2 would likely be slightly measurable within the long-term, moderate-to-major cumulative benefits to the Estes Valley economy. The moderate-to-major, cumulative benefits within the Estes Valley socioeconomic environment would continue under Alternative 2.

The beneficial effects on the Estes Valley through a reduction in landscape damage, agricultural impacts, and traffic congestion and accidents resulting from Alternative 2 would be slightly measurable in long-term, cumulative, adverse effects from future 29% population growth. The minor-to-moderate, adverse, cumulative effects within the Estes Valley socioeconomic environment would continue under Alternative 2.

Conclusion

The number of elk in the park and in the Estes Valley would be reduced as a result of lethal reduction activity, but elk distribution and behavior would be similar to that of current conditions. The intrinsic value of the elk experience would likely remain unchanged. The visitor experience of elk viewing in the park would be reduced slightly as a result of fewer, more skittish elk. There would be no effect on visitation to the park or region as a result of short-term research activities on a multi-year fertility control agent and chronic wasting disease live testing. Alternative 2 would be expected to create a net short-term, minor-to-moderate, adverse effect on tourism and recreation draw as a result of public perception of lethal reduction and redistribution techniques, but a negligible, long-term effect on visitation would be expected.

In the short-term, visitation would decrease, but long-term visitation would not be affected. Hunting activity would decrease near the east side of the park but increase near the west side. There would be no effect on hunting activity as a result of research activities due to the short study timeframe, limited number of female elk treated, and limited exposure to hunters due to the time of year the study would be conducted. There would be a net negligible-to-minor, adverse, long-term impact on hunting. Rocky Mountain National Park, Estes Park, and the Estes Valley Recreation and Park District would experience short-term loss of revenue, but long-term fiscal impacts would be negligible for all government entities. In the short and long term, there would be a minor-to-moderate benefit to homeowners and loss to landscaping companies from a decrease in elk-related damage. Agriculture would experience minor-to-moderate, short- and long-term benefits from the reduced number of elk. Traffic congestion would decrease in the short-term, but there would be minor, long-term, beneficial impacts. Elk-related traffic accidents would decrease in the short and long term, and beneficial impacts would be negligible to minor. There would be a minor, short- and long-term adverse impact on Estes Park body shops. There would be minor, short- and long-term benefits to property values. Overall, there would be a net negligible long-term impact compared to current conditions.

The moderate to major cumulative benefits within the Estes Valley socioeconomic environment would continue under Alternative 2. The minor to moderate adverse cumulative effects within the Estes Valley socioeconomic environment would continue under Alternative 2.

Alternative 3

Elk Tourism and Recreation Draw

Up to 200 elk would be lethally taken each year for 20 years, making public perceptions of lethal reduction less of an issue than in Alternative 2. Fencing around aspen (160 acres) and willow stands (440 acres) would be located in areas popular with visitors. Many park visitors come to the park for the scenery and undeveloped vistas, and fencing would have an adverse impact on their experience. This alternative would implement mitigation measures to reduce the impact of fences on visitors through design and selection of materials as described in Alternative 2.

Even with these differences, however, the impacts on elk tourism and recreation draw would be similar to those under Alternative 2.

A three-year reseach study to evaluate procedures for testing live elk for chronic wasting disease and effectiveness of a fertility control agent would have the same effects as described in Alternative 2; overall, there would be no effect on visitation to the area or park as a result of research activities.

Hunting Activity and Experience

Impacts on hunting activity and experience would be the same as under Alternative 2.

Fiscal Conditions of Governmental Entities

The impacts on fiscal conditions of government entities would be the same as under Alternative 2.

Landscaping and Property

With a decrease in the number of elk inside and outside the park to the higher end of the range of natural variation, local landowners would see minor, long-term decreases in landscaping and property damage costs. In the long-term, the elk population would be reduced by about 30%. Fewer elk in the Estes Valley would mean less elk browse and grazing, which would decrease the amount of elk-related damage. Conditions for homeowners' landscaping and property would improve, but elk-related damage would still occur, since elk would still be present. Landscaping costs would decrease by half of the percentage decrease of elk, resulting in about $50,000 in decreased annual damage costs for homeowners. In the short-term, decreases in landscaping costs would be minor due to the small amount of annual elk reduction.

Landscaping businesses would experience minor, long-term decreases in revenue due to a decrease in elk-related damage. Landscaping companies would see decreased annual revenue of up to $50,000 as the amount of elk fencing installed would decline, as would the portion of plant sales due to elk browse. In the short-term, decreases in landscaping revenue would be minor due to the small amount of annual elk reduction.

In the short term, net impacts would be negligible, as homeowner costs and company revenue would not change significantly compared to current conditions. The net long-term impact, taking into account the benefit to homeowners and the loss to landscaping companies, would be negligible compared to current conditions.

Agriculture

There would be fewer elk in the Estes Valley area compared to current conditions due to lethal reduction activity. With fewer elk on the property, the rancher would be able to graze more cattle. Management activities are assumed to affect elk in direct proportion to their current distribution. It is assumed that the percentage decrease of elk in the Estes Valley would be equal to the percentage decrease of elk on the ranch property. These alternatives would result in a decrease of between 30 to 60 elk on the ranch property and the possibility of increasing cattle by 15 to 30 animals. The increased number of cattle would increase ranch revenue by $27,000 to $54,000. Hunting is offered on the ranch, and fewer elk may reduce revenues received from hunters. This would off-set decreases in elk damage costs somewhat. With fewer elk in the Estes Valley and on the ranch property, the rancher would likely see a minor decrease in costs related to elk damage.

The rancher would likely experience minor to moderate, short and long term benefits from a reduced number of elk grazing on his property.

Traffic Accidents and Congestion

A decrease in the number elk in the park and in the Estes Park area would mean a decreased number of elk in roadways and on road shoulders, reducing the possibility of elk-related traffic congestion and traffic accidents. In the long term, the number of elk in Estes Park would be reduced by about 30%. In addition to fewer elk, there would also be 5% fewer visitors to the park and to the surrounding areas to view the elk, resulting in a decrease of accidents and congestion. The reduction in the number of elk in the area and in the number of visitors to the area would have a minor, short- and long-term benefit to traffic congestion.

The number of traffic accidents in the area would be reduced as a result of the smaller number of elk. It is estimated that the reduction of elk as a result of lethal reduction in this alternative would lead to approximately $11,000 in decreased in revenues for Estes Park auto body shops, based on the assumption that body shop revenue would drop by half the percentage decrease in the number of elk. There would be a minor, short- and long-term, adverse impact on Estes Park body shops and a minor, short- and long-term, beneficial impact on visitors.

Visitation would decrease in the short-term only, so the short-term net effect on congestion would be negligible to minor. There would be no long-term effect on congestion compared to current conditions. The net effect of a reduced number of elk in the Estes Valley on elk-related traffic accidents would be negligible to minor and beneficial in the short and long term.

Property Values

The impacts on property values would be the same as under Alternative 2.

Cumulative Impacts

The existing cumulative socioeconomic impacts would continue as described in Alternative 1. The attractions of the park and the Estes Valley cumulatively would continue to have a major, long-term, beneficial effect on the Estes Valley. Growth from sectors other than tourism would be expected to continue to contribute to long-term, moderate-to-major, cumulative benefits, and other effects from long-term growth within the Estes Valley would be expected to result in long-term, minor-to-moderate, adverse, cumulative, socioeconomic effects.

The cumulative socioeconomic environment and the cumulative effects of Alternative 3 would be the same as Alternative 2.

Conclusion

Alternative 3 would be expected to create a net short-term, minor to moderate, adverse effect on tourism and recreation draw as a result of public perception of lethal reduction, herding and aversion techniques, but a negligible long-term effect on visitation would be expected. There would be no effect on visitation to the park or the region as a result of short-term research activities on a multi-year fertility control agent and chronic wasting disease testing.

In the short-term, visitation would decrease, but long-term visitation would not be affected. The National Park Service, Estes Park and the Estes Valley Recreation and Park District would experience a short-term loss of revenue, but long-term fiscal impacts would be negligible for all government entities. In the short and long-term, there would be a minor to moderate benefit to homeowners and loss to landscaping companies from a decrease in elk-related damage. Agriculture would experience minor to moderate short and long-term benefits from the reduced number of elk. Traffic congestion would decrease in the short-term, but there would be minor, long-term beneficial impacts. Elk-related traffic accidents would decrease in the short and long-term, and beneficial impacts would be negligible to minor. There would be a minor short and long-term adverse impact on Estes Park body shops. Overall, there would be a net negligible long-term impact compared to current conditions.

Impacts on hunting activity and experience would be the same as under Alternative 2: net negligible to minor adverse and long-term.

The impacts on property values would be the same as under Alternative 2: minor short and long-term benefits. The moderate to major cumulative benefits within the Estes Valley socioeconomic environment would continue under Alternative 3. The minor to moderate adverse cumulative effects within the Estes Valley socioeconomic environment would continue under Alternative 3.

Alternative 4

Elk Tourism and Recreation Draw

Under this alternative, the target elk population would be at the high end of the natural range of variation, fluctuating between 1,600 and 2,100 animals. Elk distribution would be similar to that under current conditions, but there would be more elk outside the park near the west side during hunting season as a result of lethal reduction and redistribution techniques. Elk behavior would be similar to that under current conditions, but elk could be slightly more skittish or have a "wilder" feel to them as a result of lethal reduction and redistribution techniques.

Public perception would be a concern due to the fertility treatments, the lethal reduction activity, and the amount of fencing (up to 420 acres of habitat fenced). Between 80 and 150 elk would be lethally removed each year over the life of the plan, making lethal reduction less of an issue than fertility control treatments. Fertility control of female elk, including those that would be subject to research of control agents, could be a controversial issue for some people. Some members of the public could have a negative perception of the fertility program, since the elk would no longer feel wild to them. Short- and long-term contraception were acceptable to approximately half of survey respondents (Stewart et al. 2004); however, the combined activities of large-scale fertility control of a high number of elk for population management, lethal reduction, and fencing around vegetation would bring a cumulative risk of making the park less attractive to the public. Large-

scale fertility control, fencing, and redistribution techniques would diminish the perception of the park as a wild place. In addition, large-scale fertility control would diminish the overall reputation of the park, which would reduce visitation.

Visitation would probably diminish in the short and long-term as a result of the combined actions of fertility control for population management, lethal reduction, and fencing. There is potential for a 10% drop in visitation in both the short and long terms, which would result in a $3 million loss in sales, a $1 million loss in personal income to employees, and the loss of 75 jobs. These losses are based on a 10% decrease in current condition sales, income, and number of jobs directly related to elk. Impacts would be felt within the national park as well as in the towns and areas surrounding the park. These factors would have a moderate, adverse impact in the long term.

A three-year reseach study to evaluate procedures for testing live elk for chronic wasting disease would have the same effects as described in Alternative 2; overall, there would be no effect on visitation to the park or region as a result of research activities testing for chronic-wasting disease.

Vegetation would be improved as a result of the reduction in the number of elk and the fencing that would be installed around aspen and willow stands on the primary winter range. Survey respondents and stakeholders indicated that a balance between elk and vegetation was an important goal and that at least some aspen and willow management was needed. Vegetation improvement would have a negligible-to-minor, long-term benefit on visitation.

A net moderate, short- and long-term, adverse impact on visitation would be likely as a result of negative public perception of fertility control, lethal reduction, and fencing activities, balanced by a negligible-to-minor, long-term benefit on visitation from improved vegetation.

Hunting Activity and Experience

Elk distribution would be similar to that under current conditions, but there would be more elk outside the park during hunting season, especially near the west side, as a result of lethal reduction and redistribution techniques.

Elk treated as a result of management actions could be identified to hunters through permanent or temporary markings, based on Food and Drug Administration drug approval for consumption. Markings could include paint marks, collars, or other "do not eat" markings, and might reduce hunting interest and activity in the areas around the park. Due to the large number of elk being treated under this alternative to manage the elk population, fertility treated elk would likely move outside of the park on the west side. Currently the three-year average for elk harvest in GMU 18 is 58% cows and 42% bulls. Hunter concerns about potential problems associated with consuming a fertility treated elk would likely reduce hunter harvest, success, and pressure.

Hunter activity would likely drop by 5% as a result of the fertility control program. The drop in hunter activity would result in a loss of about $127,000 in direct economic contribution from hunters near the east and west sides of the park, based on a 5% drop in total revenue from elk hunters.

Subjecting elk to a multi-year fertility control agent and to immobilization drugs as part of a three-year research study would not result in detectable effects on hunting activity to the area compared to the large-scale control of the population with fertility control agents.

Overall, there would be a minor-to-moderate, adverse, short- and long-term impact on hunter activity and experience as a result of Alternative 4.

Fiscal Conditions of Governmental Entities

The park is expected to see a moderate to major short and long-term drop in annual elk-related entrance fee revenue due to an estimated 10% decrease in visitation, with an annual loss of revenue of approximately $100,000. The park would also see reduced revenue from its concessionaire contracts, as a reduced number of visitors would also spend less on concessions. In addition, the park would experience a moderate, short- and long-term increase in costs due to the activities of lethal reduction, redistribution, fencing, and fertility control.

The Town of Estes Park would feel a moderate to major, short- and long-term decrease in revenue due to the decrease of visitors to the area, resulting in a loss of about $100,000 in tax revenue for the town, calculated as a 10% decrease in current elk-related taxes. Decreases in costs related to elk management and damage would be negligible.

The Estes Valley Recreation and Park District would feel a minor decrease in costs in the short and long terms. Costs to the district as a result of elk-related management and damage repair would decrease by about $2,000, based on the assumption that elk-related costs would decrease by half of the percentage decrease of elk. The Estes Valley Recreation and Park District would also experience a slight decrease in revenues in the short and long terms due to decreased visitation to the area. Overall, there would be negligible net effect on the Estes Valley Recreation and Park District.

The Colorado Division of Wildlife would likely experience a minor-to-moderate increase in costs as a result of an increase in questions and concerns from residents, visitors, and hunters related to the fertility program (Leslie 2005). The Colorado Division of Wildlife would also see a minor decline in local revenue as a result of decreased hunting. A decrease of 5% in hunting activity would mean a decrease of 350 hunters in the area. Assuming 85% are Colorado residents and 15% are nonresidents (Spowart 2004), revenue loss for the Colorado Division of Wildlife would be about $35,000, based on the cost of elk-hunting licenses.

Net impacts on the public sector would be minor to moderate and adverse in the long term due to the decrease in visitors to the area.

Landscaping and Property Impacts

The impacts on landscaping and property would be the same as under Alternative 3.

Agriculture

The impacts on agriculture would be the same as under Alternative 3

Traffic Accidents and Congestion

The impacts on traffic accidents and congestion would be the same as under Alternative 3.

Property Values

There would be a decreased number of elk in the Estes Valley as a result of lethal reduction and fertility control, but the presence of elk would probably be sufficient to maintain their contribution to the quality of life in the Estes Valley. However, there would be less of a sense of the area being a wild environment, which would detract from the quality of life. With fewer elk in the area, there would be less landscape damage, fewer elk-related traffic accidents, and fewer possibilities for negative elk-human interactions, each of which would not likely impact property

values but would affect the overall quality of life. Visitation to the area would be decreased in the short and long term, but this decrease would probably not have enough impact on the local economy to affect property values. This alternative would result in a net negligible, long-term, adverse impact on property values.

Cumulative Impacts

The existing cumulative socioeconomic impacts would continue as described in Alternative 1. The attractions of the park and the Estes Valley cumulatively would continue to have a major, long-term, beneficial effect on the Estes Valley. Growth from sectors other than tourism would be expected to continue to contribute to long-term, moderate-to-major, cumulative benefits, and other effects from long-term growth within the Estes Valley would be expected to result in long-term, minor-to-moderate, adverse, cumulative, socioeconomic effects.

Visitation would probably diminish in the short and long term as a result of the actions in Alternative 4, with a moderate, adverse impact in the long-term from the loss of $3 million in sales and of 75 jobs. Hunting activity would drop by 5% (2% of the Estes Valley total sales and employment). These effects would be measurable within the long-term, moderate-to-major cumulative benefits on the Estes Valley economy, but would not be large enough to substantially reduce the county-wide effects of a strong economy. The minor-to-moderate, adverse, cumulative effects within the Estes Valley socioeconomic environment would continue under Alternative 4.

Impacts on landscaping and property, agriculture, traffic, and property values would be similar to Alternative 2. The minor-to-moderate, adverse, cumulative effects within the Estes Valley socioeconomic environment would continue under Alternative 4.

Conclusion

Visitation would probably diminish in the short and long term as a result of the combined actions of large-scale fertility control for population management and research activities, lethal reduction, and fencing. Public perception would be a concern in both the short and long terms, with a potential 10% drop in visitation in the short and long terms. This would amount to a $3 million loss in sales, $1 million in personal income, and 75 jobs. These factors would have a moderate, adverse, impact in the long term. There would be no effect on visitation as a result of short-term research on chronic wasting disease live testing.

Hunter activity would likely drop by 5% overall as a result of the fertility control program for population management. The drop in hunter activity would result in a loss of about $127,000 in direct economic contribution from hunters near the east and west sides of the park, based on a 5% drop in total revenue from elk hunters. Overall, there would be a minor-to-moderate, adverse, short- and long-term, impact on hunter activity and experience. The effects to hunting as a result of research activities involving immobilization drugs and fertility control agents would not be distinquishable from the effects of the large-scale treatment of the population.

Net impacts on the public sector would be minor to moderate and adverse in the long term due to the decrease in visitors to the area.

In the short and long-term, there would be a minor to moderate benefit to homeowners and loss to landscaping companies from a decrease in elk-related damage.

Traffic congestion would decrease in the short-term, but there would be minor, long-term beneficial impacts. Elk-related traffic accidents would decrease in the short and long-term, and

beneficial impacts would be negligible to minor. There would be a minor short and long-term adverse impact on Estes Park body shops.

This alternative would result in a net negligible, long-term, adverse impact on property values.

The minor-to-moderate, adverse, cumulative effects within the Estes Valley socioeconomic environment would continue under Alternative 4.

Alternative 5

Elk Tourism and Recreation Draw

Under this alternative, the target population range for the elk would fluctuate between 1,200 and 2,100 animals. Elk behavior would change slightly as the elk would be more skittish due to the presence of wolves, but bugling and mating behavior would remain unchanged. Elk would likely continue to congregate in open spaces, but they would be more skittish, making viewing opportunities unpredictable. The elk would be more dispersed outside the park into the Estes Valley and Grand Lake due to the presence of wolves. However, targeted elk reductions under this would result in a large enough reduction outside of the park than even with this dispersal, there would be fewer elk outside the park than under current conditions.

The public generally supports the idea of wolf release (Manfredo et al. 1994, Cordova 2000, Stewart et al. 2004, Duffield and Neher 2004) and believes that release of wolves would result in a balance of deer and elk population and a return of the natural environment to the way it once was (Manfredo et al. 1994). Wolves would become an important, long-term attraction for visitors to the park. Wolves attract visitors to Yellowstone National Park, in part due to the visibility of the wolves in the park and in part due to the idea of Yellowstone as "wolf territory" (Smith and White 2005)

Wolves would follow the elk for most of the year and would probably be most visible at the park in the winter, when elk congregate in open areas on the primary winter range. Wolves would be less visible in the park when the elk move to the primary summer range, but the possibility of seeing wolves and the knowledge that wolves are a part of the ecosystem would bring additional visitors to the park year round. Even in areas where the probability of seeing a wolf is low, such as Isle Royale National Park in Michigan, visitors come to experience "wolf territory" and to possibly see tracks and hear howling. The existence of wolves in the area would also lead to perceptions of the park as a wilder, more natural environment (Manfredo et al. 1994). The presence of wolves would result in a moderate-to-major, short -and long-term increase in visitor draw. There is potential for a 10% gain in visitors, which would result in an additional $3 million in sales, $1 million in personal income, and 75 new jobs within the National Park Service and the surrounding area.

Lethal reduction would take place to reduce the number of elk in the short-term. The most intensive lethal reduction would occur during the first four years of the program, during which time about 50 to 500 elk would be lethally removed per year. After that, lethal reduction would occur at a reduced rate of zero to 100 elk per year for the next 16 years. Lethal reduction could be a controversial issue for some park visitors and the general public. Public perception of lethal reduction efforts could impact visitation in the short term. Effects from research activities to evaluate procedures for testing live elk for chronic wasting disease and evaluating a fertility control agent would be the same as Alternative 2.

There would be a net short-term, moderate, beneficial impact on tourist draw and recreation as a result of wolf release, outweighing the adverse impact on tourist draw of lethal reduction. Some

visitors would be more likely to come to the park because of knowledge of a wolf program, while others would be less likely as a result of lethal reduction activity. In the short- and long-term, there would be a net moderate beneficial impact on park visitation and tourism in the Estes Valley as a result of the adverse effects of lethal reduction activities and the benefits of wolves drawing people to the area.

Hunting Activity and Experience

Elk would be more heavily dispersed outside the park in the Estes Valley and Grand Lake area due to the presence of wolves. There would be fewer elk outside the park near the east side as a result of lethal reduction, but there would be more elk dispersed outside the park near the west side as a result of redistribution and the presence of wolves, in the short-term.

Decreased numbers of elk near the east side of the park would result in a short- and long-term decrease in the number of hunting licenses available (Leslie 2005). This would result in a slight decline in elk harvest in the east side of the park, which would have a minor net adverse effect near the east side. There would be potential for a 2% to 3% decrease in the number of hunter days near the east side, which would mean a loss of between $16,000 and $24,000 of direct economic contribution due to decreased elk hunting near the east side, based on a decrease of 2% to 3% of hunter-based revenue. There would be a negligible-to-minor, adverse impact on hunters and the Estes Park community near the east side of the park.

The increase in the number of elk near the west side of the park could result in a short-term increase in hunter activity in the area. The proximity of wolves would lead to perceptions of the park and the areas adjacent to the park as being a wilder, more natural environment (Manfredo et al. 1994), which could also lead to an increased interest in hunting in the area, but the release of wolves as a predator of elk in other areas has met with resistance from hunters (Smith and White 2005). Hunters could have a negative view on wolf release, since wolves would prey on elk and further reduce the elk population.

It is estimated that there is potential for a 2% to 3% short-term increase in hunter days near the west side of the park, due to the short-term increase in elk numbers outside the park as a result of redistribution techniques. Increased hunting activity near the west side of the park would result in an increase of approximately $34,000 to $51,000 of direct economic contribution due to elk hunting, calculated as a 2% to 3% increase in west side hunter-related revenue. In the long-run, elk numbers would decrease overall, and there would be fewer elk near the west side of the park, so hunting activity would return to current levels or decrease.

In the short-term, hunting near the east side of the park would be adversely affected by a reduction of elk and more skittish elk, and hunting near the west side would be positively affected as elk would be pushed out of the park by redistribution activities and wolves. Short-term, there would be a net negligible-to-minor impact on hunting activity as a result of this alternative. In the long-term, hunting activity near the east side would continue at a decreased level, and hunting near the west side would probably continue at original levels, since there would be fewer elk in the area as a result of lethal reduction and wolf activity, and elk would be more likely to seek refuge in town. There would be a net negligible-to-minor, adverse, long-term impact.

As described in Alternative 2, research activities involving immobilization drugs and a multi-year fertility control agent on a small number of female elk over a three-year period of the plan would have no effect on hunting activity in the area.

Fiscal Conditions of Governmental Entities

Wolves would become an attraction for visitors, and the park is expected to see a moderate-to-major, long-term increase in annual elk-related NPS entrance fee revenue, due to an estimated 10% increase in visitation related to the presence of wolves. The increase in revenue would be approximately $100,000, and the park would also see increased revenue from its concessionaire contracts, as a larger number of visitors would spend more on concessions. In addition, the park would experience a moderate, short- and long-term increase in costs due to the activities of wolf management, lethal reduction, herding, and fencing.

The Town of Estes Park would experience a moderate-to-major, long-term increase in revenue due to the estimated 10% increase in park visitors. The increase in visitors to the Estes Valley would result in an increase of about $100,000 in tax revenue for the town, calculated as a 10% increase in current elk-related taxes. Decreases in costs related to elk management and damage would be negligible.

The Estes Valley Recreation and Park District would experience a minor decrease in costs in the short and long terms due to decreased elk near the east side of the park. Costs to the district as a result of elk related management and damage repair would decrease by about $2,500, based on the assumption that elk-related costs would decrease by half of the percentage decrease of elk. The Estes Valley Recreation and Park District would also experience an increase in revenue in the short and long terms due to an increase of visitors to the area to experience wolves. Overall, there would be negligible-to-minor net effects on the Estes Valley Recreation and Park District.

Wolves would have a moderate-to-major, adverse impact on Colorado Division of Wildlife costs. Increased costs would result from an increase in questions and concerns from residents, visitors, and hunters related to the release of wolves (Leslie 2005). The Colorado Division of Wildlife would have to put additional time and money towards investigating complaints and answering questions. The division would see hunting-related costs and revenue similar to those under current conditions, since the decrease in hunting activity near the east side of the park would be offset by increased hunting activity near the west side. Long-term changes in fiscal conditions for the Colorado Division of Wildlife would be moderate to major.

Changes in long-term visitation to the park and the Estes Valley would be moderate to major; therefore, net long-term fiscal impacts would be moderate for all jurisdictions.

Landscaping and Property

The presence of wolves in the park would create greater dispersion of elk into areas outside the park, especially in the winter. Even though the existence of wolves in the park would cause elk to disperse out of the park, there would still be fewer elk in the Estes Valley than under current conditions. In the short term, the elk population would be reduced by about 10%; in the long-term by about 37%. It is estimated that local homeowners would see a minor, long-term decrease in landscaping costs due to the fewer number of elk in the Estes Valley. Homeowners would see a minor, short-term decrease in landscaping costs due to the reduced number of elk in town as a result of lethal reduction activity in the park. The extent of elk dispersion due to wolves is uncertain, so the change in landscaping costs is also uncertain, but annual landscaping costs could decrease by up to $68,000. It is assumed that landscaping costs would decrease by half of the percentage decrease of elk.

Landscaping businesses would experience minor, short- and long-term decreases in revenue of up to $68,000 due to a decrease in elk-related damage. The amount of fencing installed for elk would decline, as would the portion of plant sales due to elk browse.

There would be a small likelihood of wolves predating on pets and other domestic animals. If this were to occur, it would result in a short- and long-term, minor, adverse impact at a community level, although, individual pet owners may be substantially affected.

The net short- and long-term impact, taking into account the benefit to homeowners and the loss to landscaping companies, would be negligible compared to current conditions.

Agriculture

The presence of wolves in the park would create greater dispersion of elk into areas outside the park, especially in the winter. Even with increased dispersal out of the park, there would still be fewer elk in the Estes Valley than under current conditions due to lethal reduction activity and a number of elk being killed by wolves. It is assumed that the percentage decrease of elk in the Estes Valley would be equal to the percentage decrease of elk on the ranch property. This alternative would result in a decrease of between 39 to 78 elk on the ranch property and the possibility of increasing cattle by 20 to 39 animals, increasing ranch revenue by $36,000 to $70,000. With fewer elk in the Estes Valley and on the ranch property, the rancher would likely see a minor decrease in costs related to elk damage. Hunting is offered on the ranch, and fewer elk may reduce revenues received from hunters. This would offset decreases in elk damage costs somewhat.

The rancher would likely experience some anxiety and concern regarding livestock losses due to wolf kills. It is highly unlikely that any livestock would be affected by the release of wolves, since the park has included a substantial monitoring program to keep track of and manage the wolves to stay inside the park boundary, which should prevent cattle loss. If wolves do attack livestock or cause any livestock deaths, they would be lethally removed.

There would be a net minor-to-moderate, short- and long-term benefit to agriculture from decreased numbers of elk grazing on the ranch property compared to current conditions.

Traffic Accidents and Congestion

The presence of wolves in the park would create greater dispersion of elk into areas outside the park, especially in the winter; however, there would still be fewer elk in the Estes Valley than under current conditions due to lethal reduction activity and a number of elk being killed by wolves. There would be fewer elk grazing in areas outside the park and fewer elk on or near roadways outside the park. In the short term, the number of elk in Estes Park would be reduced by about 10%; in the long-term, the elk population would be reduced by about 37%. On the other hand, the wolves are expected to be a strong attraction in the long-term, increasing net visitation by 10% and therefore also increasing the number of vehicles in the area and congestion.

The number of elk-related traffic accidents in the area would be reduced as a result of the smaller number of elk in the area. The change in costs to drivers and in the revenue of body shops is uncertain due to the unknown extent of elk dispersal outside the park. It is estimated that if elk are reduced in proportion to their current distribution (no dispersion on top of lethal reduction), there would be approximately $14,000 of cost savings for drivers and revenue decrease for Estes Park body shops, based on the assumption that body shop revenue would drop half the percentage decrease in the number of elk. If elk are dispersed into town, drivers would not realize as much savings, and body shops would not see as much revenue loss. There would be a minor, short- and long-term, adverse impact on Estes Park body shops and a minor, short- and long-term, beneficial impact on visitors compared to current conditions.

Property Values

There would be a decreased number of elk in the Estes Valley as a result of lethal reduction and wolf activity, but the presence of elk would probably be sufficient to maintain their contribution to the quality of life in the Estes Valley. In addition, there would be more of a sense of the area being a wild environment, which would add to the quality of life. With fewer elk in the area, there would be a lower amount of landscape damage, fewer elk-related traffic accidents, and fewer possibilities for negative elk-human interactions, each of which would not likely impact property values but would affect the overall quality of life. Visitation to the area would increase in the long term due to the attraction of the wolves, which would provide an economic stimulus to the local area. This long-term increase might have enough impact on the local economy to affect property values. This alternative would result in a net minor, long-term, beneficial impact on property values.

Cumulative Impacts

The existing cumulative socioeconomic impacts would continue as described in Alternative 1. The attractions of the park and the Estes Valley cumulatively would continue to have a major, long-term, beneficial effect on the Estes Valley. Growth from sectors other than tourism would be expected to continue to contribute to long-term, moderate-to-major, cumulative benefits, and other effects from long-term growth within the Estes Valley would be expected to result in long-term, minor-to-moderate, adverse, cumulative, socioeconomic effects.

The release of wolves would increase visitor draw and would result in an additional $3 million in sales and 75 new jobs (2% the Estes Valley total sales and employment). Hunting would decline near the east side in the short-term, but would be negligibly affected in the long term. Government entities would receive revenue benefits that would range from minor to major. The effects of these would be measurable within the long-term, moderate-to-major cumulative benefits on the Estes Valley economy and would contribute to the continuation of this level of cumulative effect on the socioeconomic environment.

Impacts on landscaping and property, agriculture, traffic, and property values would be similar to Alternative 2. The minor-to-moderate, adverse cumulative, effects within the Estes Valley socioeconomic environment would continue under Alternative 5.

Conclusion

The presence of wolves would result in a moderate-to-major, short- and long-term increase in visitor draw. There is potential for a 10% gain in visitors, which would result in an additional $3 million in sales, $1 million in personal income, and 75 new jobs within the park and the surrounding area. In the long-term, there would be a net moderate beneficial impact on park visitation and tourism in the Estes Valley as a result of the adverse effects of lethal reduction activities and the benefits of wolves drawing people to the area. There would be no effect on visitation to the park or the region as a result of short-term research activities on a multi-year fertility control agent and chronic wasting disease testing.

In the short-term, hunting near the east side of the park would be adversely affected by a reduction of elk and more skittish elk, and hunting near the west side would be positively affected as elk would be pushed out of the park by redistribution techniques and wolves. Short term, there would be a net negligible to minor impact on hunting activity as a result of this alternative. In the long term, hunting activity near the east side would continue at a decreased level, and hunting near the west side would probably continue at original levels, since there would be fewer elk in

the area as a result of lethal reduction and wolf activity, and elk would be more likely to seek refuge in town. There would be no effect on hunting activity as a result of research activities due to the short study timeframe, limited number of female elk treated, and limited exposure to hunters due to the time of year the study would be conducted.

There would be a net negligible-to-minor, adverse, long-term impact.

Wolves would become an attraction for visitors, and the park would probably see a moderate-to-major, long-term increase in annual elk-related entrance fee revenue and a moderate, short- and long-term increase in costs, due to the activities of wolf management, lethal reduction, herding and fencing.

The Town of Estes Park would experience a moderate-to-major, long-term increase in revenue, due to the estimated 10% increase in park visitors. The Estes Valley Recreation and Park District would experience a negligible to minor net effect due to decreased elk near the east side of the park and increased visitors. Wolves would have a moderate-to-major negative impact on CDOW costs.

Local homeowners would likely see a minor, short- and long-term decrease in landscaping costs due to the fewer number of elk in the Estes Valley. The net short- and long-term impact, taking into account the benefit to homeowners and the loss to landscaping companies, would be negligible compared to current conditions. There would be short- and long-term, minor, adverse impact as a result of potential wolf depredation on pets

There would be a net minor to moderate short and long-term benefit to agriculture from decreased numbers of elk grazing on the ranch property compared to current conditions.

There would be a minor short and long-term adverse impact on Estes Park body shops and a minor short and long-term beneficial impact from reduced accidents.

There would be a net minor long-term beneficial impact on property values.

The minor to moderate adverse cumulative effects within the Estes Valley socioeconomic environment would continue under Alternative 5.

PUBLIC HEALTH AND SAFETY

Rocky Mountain National Park is responsible for maintaining safe conditions that protect the health and safety of employees and the public.

Summary of Regulations and Policies

Management Policies (2006b) requires that

> Parks provide a safe and healthful environment for visitors and employees.
>
> Management actions strive to protect human life and provide injury-free visits to the extent that they will not impair park resources and values.
>
> Management actions reduce or remove known hazards and apply other appropriate measures, including closures, guarding, signing, or other forms of education
>
> Parks ensure compliance with applicable federal, state, and local public health laws, regulations, and ordinances.

Management Policies recognizes that when addressing safety and health issues, park managers must work within funding and staffing limits.

Director's Order #50B: Occupational Safety and Health Program addresses the policy, requirements, and responsibilities for managing an effective occupational safety and health program for NPS employees. It requires parks to integrate safety and health into every operation and activity. Parks must meet or exceed all applicable statutory, regulatory, and policy requirements relating to safety, health, and the environment, applying the more stringent requirement when conflicts exist between standards, or developing standards if none exist. Employees must adhere to established occupational safety and health procedures. Employees will receive specialized training when appropriate to safely perform assigned tasks and to respond effectively to recognized potential emergencies. Authorized agents of the National Park Service as described in Appendix H will comply with all applicable safety and health provisions and requirements (NPS 1999b).

Director's Order #50C: Public Risk Management Program implements a process to minimize the occurrence of visitor injury or illness and achieve maximum effectiveness in communicating risk to the public, without negative impacts on park resources. The service will strive to protect human life and provide an injury-free visit within the constraints of the 1916 Organic Act and available resources. Park visitors assume a substantial degree of risk and responsibility for their own safety when visiting areas that are managed and maintained as natural, cultural, or recreational environments. To minimize the number and severity of visitor incidents, parks will use risk assessment to develop appropriate mitigation strategies (NPS 2001d).

Director's Order #77-4: Use of Pharmaceuticals for Wildlife requires that all personnel performing remote delivery of pharmaceutical to wildlife must qualify, at a minimum, semi-annually with the type(s) of firearm(s) used, including safety, marksmanship, maintenance, storage, performance, limitations of weapons, accountability and control, and security. Such personnel must follow all Drug Enforcement Agency regulations when handling or using anesthetics or controlled substances, and must obtain certification to administer anesthetics or controlled substances to wildlife. Projects involving such substances must develop protocols for the use of anesthetics or controlled substances for wildlife (NPS 2002a).

Director's Order #83G: Vector-borne and Zoonotic Diseases calls for monitoring and dissemination of data about vector-borne diseases and the agents that spread them. Parks must ensure that educational materials are available for park staff and visitors, and conduct or coordinate preventive education and training sessions (NPS 2003a).

Methodologies and Assumptions for Analyzing Impacts

Safety concerns for this plan fall into two broad categories: risks posed by the elk and risks posed by management of elk and over-browsed vegetation. Detailed discussion of these risks can be found in Chapter 1, "Purpose of and Need for Action." Chapter 2, "Alternatives," discusses current and proposed management activities, including mitigation of risks associated with those activities.

Geographic Area Evaluated for Impacts

This discussion analyzes the impacts on public health and safety in the park where management activities take place.

Management actions within the park may affect the behavior of elk that move outside the park. Human-elk interactions are analyzed both in the park and within the Estes Valley.

Issues

Public health and safety issues identified during internal and public scoping related to elk and to management activities for elk and vegetation include the following:

- Human proximity to wildlife in Rocky Mountain National Park involves risk during traffic encounters or when people approach elk during elk viewing.
- Traffic congestion when elk congregate in meadows visible from the roads may cause vehicle-vehicle or vehicle-pedestrian collisions.
- Pharmaceuticals used in some lethal control or fertility control operations involve inherent risks.
- Equipment used in lethal control operations involves inherent risks.
- NPS staff or authorized agents of the National Park Service may receive injuries when handling wildlife.
- Carcass handling and disposal may put NPS staff or their authorized agents at risk of disease or injury.
- People who consume meat from elk treated with fertility control drugs or from elk infected with chronic wasting disease may incur health risks.
- Fence construction and maintenance may result in injuries to park staff and contractors.
- Prescribed burning involves risks such as smoke inhalation and burn injuries.
- High elk abundance and density may contribute to increased prevalence of chronic wasting disease (CDOW 2004c). Concern, perceived or real, has been raised regarding human health and safety in the presence of the disease.

Impacts on park management and operations were evaluated using the process described in the "General Methodology for Establishing Impact Thresholds and Measuring Effects by Resource"

section near the beginning of this chapter. Information used in the analysis was obtained from meetings attended by park representatives and other interested governmental agencies, interviews with experts, literature searches, visitor surveys in the park, and input from members of the public.

Impact Threshold Definitions

Intensity of Impact

Negligible: Employee or visitor health and safety would not be affected, or effects would not be appreciable or measurable.

Minor: Effects on employee or visitor health and safety would be detectable but would not produce an appreciable change.

Moderate: The effects would be readily apparent, and would result in noticeable changes in employee or visitor health and safety. Changes in rates or severity of injury could be measured.

Major: The effects would be readily apparent, would result in substantial changes in employee or visitor health and safety, and could lead to employee or visitor mortality.

Type and Duration of Impact

Beneficial impacts would improve human health and safety or would reduce risks to human health and safety.

Adverse impacts would increase risks to human health and safety.

Duration: With short-term impacts, effects on human health and safety would persist for less than one year. With long-term impacts, effects on human health and safety would persist for one year or more.

Impacts Common to All Alternatives

Because removal of elk exhibiting chronic wasting disease symptoms would be an element of any alternative, safety considerations include those associated with sedating elk and handling sedated elk as well as risks for users and bystanders associated with firearms use (lethal and non-lethal rounds). NPS-required safety measures, such as *Director's Order #50B: Occupational Safety and Health Program* (NPS 1999b), reduce such risks to negligible-to-minor levels.

Monitoring elk and vegetation would be a component of any alternative implemented by the park. The Resources Management Division conducts and would continue to conduct elk monitoring along several routes on a regular schedule, supplemented by occasional aerial monitoring. The types of risks would be similar across alternatives, although intensities would vary with different frequencies of monitoring. Following standard NPS mitigation measures reduces the risks and adverse impacts to a negligible level.

Alternative 1

Elk Management

Park visitors' efforts to view or photograph elk or recreate in areas that elk congregate incur risks such as such as charging, trampling, and goring. Other hazards include traffic congestion, cars stopping on roads, car doors left open, pedestrians on roads, and resultant accidents. Such encounters are most likely during the spring calving season and fall rut, when elk are more aggressive than during the rest of the year (Elverum n.d.). To date, elk aggressiveness toward humans in Rocky Mountain National Park is still unusual. Within the past five years, bull elk twice charged hikers during the fall rut (once each on Hollowell Trail and Cub Trail), and a mother charged visitors in the spring to protect her newborn calf. No injuries resulted during these incidents (Langdon 2005f). These incidents represent only what has been reported during times that volunteers are present. Actual numbers may be higher. Currently, impacts on visitors over the long term are negligible and adverse.

As elk-human interactions increase in Rocky Mountain National Park and within the Estes Valley, whether due to high elk population, reduced elk mobility, or increasing visitation, the risk of aggressive elk behavior and human injuries may increase. This could increase the intensity of long-term, adverse risks from negligible to minor.

Mitigation of these risks could involve education (signs, pamphlets, notices in local papers, and broadcast media coverage) and area closings during calving and rutting seasons. In addition, aggressive elk could be marked, as in Canada's Banff National Park, where repeat offenders are aversively conditioned; they could be removed from the park or Estes Valley, or as a last resort, they could be destroyed (Elverum n.d.). Park staff and volunteers try to keep visitors at a safe distance at popular elk viewing areas in Rocky Mountain National Park, but ultimately, visitors are responsible for their own safety.

Park staff and volunteers face risk from elk as they perform their duties. Crowd control places them between visitors and elk. Euthanizing injured elk or those showing clinical signs of chronic wasting disease involves the possibility of injury from the animal, wildlife drugs, or from firearms. Handling carcasses can result in lifting injuries. Aversive conditioning of elk exposes staff to possible goring or trampling. The park has created various protocols, procedures, and plans to mitigate these risks (NPS 2001g, 2001e, 2001f, 2002c, 2002e, 2002f, 2004e, 2005d, 2005e). As a result, Natural Resource staff have conducted lethal control of injured or chronic wasting disease-positive elk and deer since 1981 with no injuries (Watry 2005f). The impact of elk control activities is long term, negligible to minor, and adverse.

Chronic wasting disease is a transmissible spongiform encephalopathy disease that attacks the brains of infected deer and elk. Like similar diseases such as scrapie in sheep and bovine spongiform encephalopathy in cows, it appears to be spread by prions, infectious protein particles similar to viruses but lacking nucleic acid (Belay et al. 2004). As the disease progresses, infected animals become emaciated, display abnormal behavior, lose bodily functions, and die (CDOW 2003a). The transmissibility of chronic wasting disease from infected elk carcasses to humans may be possible but appears to be unlikely, although many people perceive it as a real risk (Belay et al. 2004; CDOW 2003a).

Colorado Division of Wildlife precautions for hunters and others taking elk or deer in infected areas include not shooting, handling, or consuming animals that appear sick; wearing rubber gloves when field dressing or processing animals, minimizing handling of brain, spinal cord, eyes, spleen, tonsils, pancreas and lymph nodes; and washing hands and disinfecting instruments thoroughly after processing animal (CDOW 2003a). Current belief is that lower density could

decrease chronic wasting disease prevalence and therefore any associated risk of transmission to members of the public (CDOW 2004c).

Because chronic wasting disease is expected to persist in the elk population near the park, and the elk population would remain unnaturally dense under current management practices, the possibility of chronic wasting disease transmission to humans under Alternative 1 would remain long term, negligible, and adverse.

The park first euthanized a chronic wasting disease suspect elk in 1981. Additional suspect elk were lethally removed in 1998 and in 2001. Since 2002 several elk are removed each year. No injuries have been sustained in these operations (Watry 2005f). To minimize risks, the park has developed an interim action plan for personnel treating and handling elk and deer (2001g), and all personnel must complete a firearms safety course and demonstrate proficiency by a firearms qualification test before using dart rifles or other firearms in field operations (Watry 2005f). Training must include safety, marksmanship, maintenance, storage, performance, limitations of weapons, accountability and control, and security (NPS 2002a). These risk-reduction measures would result in long-term, negligible-to-minor, adverse impacts for staff. This would also apply to contractors if their contracts specified that similar training was required.

Vegetation Management

Vegetation management under Alternative 1 consists primarily of using fencing to keep elk away from vulnerable plants in developed areas and out of 26 research plots covering 12 acres. Fence repairs involve little risk to staff, as does freeing elk or other animals that get trapped within exclosures. Because aspen and willow communities would not recover sufficiently under current management to allow prescribed burns, there would be no risks associated with such actions. The long-term, adverse impacts on public health and safety of vegetation management under Alternative 1 are negligible.

Cumulative Impacts

Public and employ health and safety are affected throughout the park by the interactions of people with the natural environment, with other people, and with park operations activities. Past, present, and future actions of the National Park Service are directed towards meeting statutory and regulatory health and safety requirements and managing risks to the public and employee. The 2002 snowmobile management plan and environmental assessment would reduce emission and provide negligible benefits for public health (NPS 2002b). Reduced opportunities for collisions and accident, including those with nonmotorized visitors, would result in negligible-to-minor benefits. The planned headquarters area emergency operations center would include a six-bay fire station and would improve emergency response capability to provide a moderate, beneficial impact. The transportation management plan (to be developed) and the reconstruction of the Bear Lake Road would reduce congestion and improve traffic and transportation safety, resulting in minor-to-moderate, beneficial effects. The ongoing mule deer testing and monitoring program for chronic wasting disease would improve determinations of the prevalence of chronic wasting disease in mule deer and removal of infected animals, resulting in long-term, negligible benefits to public health and safety. Wildland and structural fire fighting presents risks to staff through exposure to fire, helicopter flights, and operation of equipment and tools and create short-term, moderate adverse impacts on staff health and safety. Regular traffic management activities, such as directing cars at busy parking areas and intersections, during times of peak visitation results in current and future, short-term, minor adverse impacts. The past, present, and future

actions to improve public health and safety would offset the current and future adverse effect, and would result in long-term, minor-to-moderate, cumulative impacts on public health and safety.

Alternative 1 would continue the adverse effects of park visitors' efforts to view or photograph elk, and the risks that park staff encounter when managing visitors viewing elk. Park staff would continue to encounter risks when monitoring for chronic wasting disease and the condition of vegetation. The effects of Alternative 1 on public health and safety would be slightly detectable when combined with the minor-to-moderate, cumulative, beneficial impacts from past, present, and future action, and would result in a continuation of cumulative impacts at that level.

Conclusion

Park visitors' efforts to view or photograph elk incur risks such as such as charging, trampling, and goring. Impacts on visitors over the long term are negligible and adverse. This could increase the intensity of long-term, adverse risks from negligible to minor with increased visitation. Park staff and volunteers face risk from elk as they perform their duties. The impact of elk control activities is long term, negligible to minor, and adverse.

The possibility of chronic wasting disease transmission to humans from handling elk under Alternative 1 would remain long term, negligible, and adverse. The use of firearms and dart rifles for lethal control of elk infected with chronic wasting disease results in long-term, negligible-to-minor, adverse impacts for staff or contractors. The long-term, adverse impacts on public health and safety of vegetation management, including fencing, under Alternative 1 are negligible.

The effects of Alternative 1 on public health and safety would be slightly detectable when combined with the minor to moderate cumulative beneficial impacts from past, present, and future actions, and would result in a continuation of cumulative impacts at that level.

Alternative 2

Elk Management

During the first four years of the plan, NPS staff and their authorized agents would participate in lethal control activities and NPS staff would conduct a three-year research study to evaluate procedures for testing live elk for chronic wasting disease and effectiveness of a fertility control agent. Due to the high level of activity and management of elk during this period, chances for staff injury would increase. As lethal control activities would decline after the first four years, related risk to staff would decrease due to decreased elk-related duties. Training of personnel and application of existing safety procedures would mitigate this risk, as well as risk of injury to visitors. Mitigation could also include use of subsonic ammunition, which has a shorter range than conventional rounds, and shooting from elevated stands to reduce the distance bullets could travel. Temporary area closures where operations occur, conducting operations at low-use times such as night and early morning, and public education would also reduce risks to visitors. Together, these measures would keep the short- and long-term, adverse impacts at a negligible-to-minor intensity.

Darts may also be used to immobilize elk before euthanizing or for research purposes, which involves risks of accidental injection as well as injury from darts. Precautions for accidental exposure such as keeping the gun unloaded and unpressurized with the safety on until just before use, never pointing the muzzle at others, and securing areas before operations begin can prevent accidental administration to humans of the sedative. Other precautions include never working alone, wearing gloves and eye protection when loading or handling darts to minimize risk of

absorbing agent through the skin or eyes, and having specialized first aid training and kits. Short- and long-term, adverse impacts on health and safety associated with dart gun use and with handling drugged animals would be mitigated by adherence to *Director's Order #77-4: Use of Pharmaceuticals for Wildlife* (NPS 2002a), job hazard analysis policies, and capture protocols, keeping these impacts at a negligible-to-minor level.

Reduced elk numbers, concentrations, and habituation in the park would reduce elk-human interactions. Animals rapidly dispersing during lethal control activities using unsuppressed firearms would slightly increase the risk of elk encounters with humans and vehicles; suppressed-noise weapons would virtually eliminate this risk, resulting in a short-term, negligible, adverse impact. Overall, encounters would decrease to the lowest level among the alternatives as elk numbers decrease, a long-term, negligible-to-minor, beneficial impact on health and safety.

Redistribution activities that would be used to drive elk away from sensitive vegetation would also serve to reduce habituation to humans. This would contribute to the long-term, minor benefits on human health and safety.

As elk numbers dropped after the first few years, hunting would also decrease. As hunting opportunities decreased, fewer hunters would inadvertently cross into the park from surrounding lands, reducing the risk to staff and visitors in the park.

A capture facility could be used for lethal reduction actions. Assembling, disassembling, and transporting mobile facilities involve risk of abrasion and crushing. Elk entering or within the facility could become agitated, especially by the sight of humans, increasing risk to handlers. Placing a cardboard lining along the entry chute can reduce agitation, and elk could be moved in small groups rather than in large groups (Grandin 1999). Adverse impacts on health and safety would be short term and negligible to minor.

Herding or bait lines would be needed to get elk to the facility. Horse or dog use, or helicopters as an adaptive tool would each involve risks, which would be mitigated by following standard practices and NPS procedures. Precautions include using techniques to avoid agitating the animals, remaining alert for warning signs of aggression, and proper defensive measures (Grandin 1999; Kloppers et al. 2004). Mitigation also includes separating the public and herding activities to reduce the risk of injuries resulting from goring and trampling (Kloppers et al. 2004). These mitigation measures would result in long-term, negligible-to-minor, adverse impacts from activities associated with elk capture and lethal taking.

Current knowledge suggests that chronic wasting disease is not transmissible from animals to humans (CDOW 2003a). Therefore, most risks associated with chronic wasting disease would result from handling carcasses for chronic wasting disease testing and with carcass disposal, such as cuts from knives and saws or strains from moving heavy animals, or from use of sharp implements to obtain biopsies from live elk as part of the research study, which would last for three years. A reduced elk population would result in handling fewer carcasses and, combined with required training, would reduce short- and long-term, adverse impacts on health and safety from these activities to a negligible level. In the short-term, the substantial increase in carcass handling within a compressed time frame could increase risk. This could be mitigated by adequate staffing, equipment, and training.

Vegetation Management

Elk population reduction would change vegetation management in the park, which would in turn affect public health and safety. Fencing aspen clones would involve slightly elevated risks for

staff or contractors who erect, maintain, and take down fences. Effects on public health and safety from activities associated with fencing would be short term, negligible, and adverse.

As vegetation was protected from over-browsing, prescribed burning or mechanical thinning may be used to approximate natural processes that stimulate plant growth. Risks associated with mechanical thinning would be mitigated by following standard safety precautions when working with power tools and heavy machinery and by closing work areas to the public. The park's fire management plan includes mitigation for the risks, such as smoke inhalation or accidental injuries, associated with prescribed burns (NPS 2004a). In addition, fire personnel at the park must meet training and qualifications requirements (NWCG 2000) and follow all safety policies, standards, and guidelines (NWCG 2004a, 2004b, and 2004c; NIFC 2002, 2005). Road and area closures to visitor use would improve safety of visitors and fire personnel. Effects on public health and safety from thinning or prescribed burns would be short term (for individual operations) or long term (the life of the plan), minor, and adverse.

Smoke from fire may degrade air quality, a risk to public health. Fire management techniques, as used by the National Park Service and found in the park's fire management plan, minimize the amount of smoke produced by prescribed burns and reduce how much of that smoke drifts into smoke-sensitive areas such as population centers and roads. Mitigation measures also include encouraging workers and volunteers to stay upwind of fire and using signage to alert visitors to planned burns so that they may avoid exposure to the smoke and burning when environmental conditions would carry smoke away from population centers. As a result, adverse impacts on public health and safety due to smoke would be short term and negligible.

Cumulative Impacts

The existing cumulative public health and safety impacts would continue as described in Alternative 1. The combined effects of past, present, and future plans that would beneficially affect public health and safety and the adverse effects of current and future conditions on staff safety would continue to result in long-term, minor to moderate, beneficial cumulative impacts on public health and safety.

Alternative 2 would result in increased risks to health and safety through lethal control operations and the installation of fences. Reduced numbers, concentrations, and habituation of elk would decrease risks to visitor health and safety. The effects of Alternative 2 on public health and safety would be slightly detectable when combined with the minor-to-moderate, cumulative, beneficial impacts from past, present, and future action, and would result in a continuation of cumulative impacts at that level.

Conclusion

Lethal control activities and research activities would result in short- and long-term, adverse impacts on employee health and safety at a negligible-to-minor intensity. Use of darts and handling of drugged animals for lethal reduction or research activities would have short- and long-term, adverse impacts on health and safety that would be mitigated by adherence to NPS policies, guidance, and protocols to a negligible to minor level.

Reduced elk numbers, concentrations, and habituation in combination with redistribution activities would reduce encounters to the lowest level among the alternatives and result in a long-term, negligible-to-minor, beneficial impact on health and safety. Capture facilities for lethal reduction and research activities would have adverse impacts on health and safety that would be short-term and negligible to minor. Herding or bait lines would be needed to get elk to the

facility and would result in long-term, negligible-to-minor, adverse impacts. Reduced elk population would result in handling fewer carcasses and would result in long-term, negligible, adverse impacts.

Effects on public health and safety from activities associated with fencing would be short-term, negligible, and adverse. Effects on public health and safety from thinning or prescribed burns would be short-term (for individual operations) or long-term (the life of the plan), minor, and adverse. Adverse impacts on public health and safety due to smoke would be short term and negligible.

The effects of Alternative 2 on public health and safety would be slightly detectable when combined with the minor to moderate cumulative beneficial impacts from past, present, and future actions, and would result in a continuation of cumulative impacts at that level.

Alternative 3

Elk Management

Because population reduction would be more gradual and on a smaller scale than for Alternative 2, long-term changes to effects on public health and safety posed by the elk population and activities to manage it would be similar, somewhat less intense, and would remain constant through the 20 years of plan implementation. Darting and handling of elk for lethal reduction or research activities would be the same as Alternative 2. Safety measures implemented during lethal reduction activities and research activities would keep the associated short- and long-term, adverse impacts at a negligible-to-minor intensity. The gradually decreasing elk population under this option would have impacts on human-elk interactions similar to that of Alternative 2.

Because this option would involve taking fewer elk than under Alternative 2, chronic wasting disease risks compared to Alternative 2 would probably be slightly less for staff and contractors testing and removing carcasses. Impacts as a result of the research study to test biopsy procedures on live elk for chronic wasting disease would be the same as Alternative 2. Required training would reduce short- and long-term, adverse impacts on health and safety from handling carcasses of elk suspected to be infected with chronic wasting disease to a negligible level.

Because the target population would be larger than under Alternative 2 and the reduction would be more gradual, a greater number of habituated elk would require redistribution activities, especially during the early years. More frequent conditioning sessions would expose conditioners and bystanders to a slightly greater probability of conflict with elk. Staff training and limited area closures would keep associated short-term, adverse impacts on health and safety at a negligible-to-minor level.

Outside the park, the gradual reduction of the elk population would reduce elk numbers, so impacts of human-elk interactions outside the park on public health and safety would be long term, negligible, and beneficial.

Vegetation Management

The more extensive fencing compared to Alternative 2 would increase risks of lacerations, bruises, and crush injuries associated with installation and maintenance. Mitigation would include standard industry safety measures. Freeing wildlife that find a way into the exclosures could put staff at some risk, especially if the animals panic. Mitigation would include precautions similar to those used when herding or conditioning animals under Alternative 2, and staff would

work in pairs in case one person got injured. Effects on public health and safety from activities associated with fencing would still be short-term, negligible, and adverse.

Because fencing would allow protection of aspen and willow communities from elk herbivory, prescribed burning and mechanical thinning would become available as management tools. Risks and mitigation would be the same as under Alternative 2.

Cumulative Impacts

The existing cumulative public health and safety impacts would continue as described in Alternative 1. The combined effects of past, present, and future plans that would beneficially affect public health and safety and the adverse effects of current and future conditions on staff safety would continue to result in long-term, minor to moderate, beneficial cumulative impacts on public health and safety.

Alternative 3 would result in increased risks to employee safety from the increased amount fence that would be installed. However, when combined with the cumulative impacts of past, present, and future actions, the cumulative impacts of Alternative 3 would be the same as Alternative 2.

Conclusion

The gradually decreasing elk population under this alternative would reduce elk numbers, concentrations, and habituation to humans in combination with aversive conditioning activities and would reduce encounters to the lowest level among the alternatives. This would result in a long-term, negligible to minor, beneficial impact on health and safety. Use of darts and handling of drugged animals during lethal reduction or research activities would have short- and long-term, adverse impacts on health and safety that would be mitigated by adherence to NPS policies, guidance, and protocols to a negligible to minor level. Adverse impacts on health and safety from handling elk carcasses and live elk to be tested for chronic wasting disease would be at a negligible level.

Staff training and limited area closures during more frequent redistribution actions would keep associated short-term, adverse impacts on health and safety to a negligible-to-minor level. Outside the park, the gradual reduction of the elk population would reduce elk numbers, so impacts of human-elk interactions outside the park on public health and safety would be long term, negligible, and beneficial.

The more extensive fencing compared to Alternative 2 would increase risks, and the effects on public health and safety from activities associated with fencing would still be short-term, negligible, and adverse. The effects of prescribed burning and mechanical thinning would be the same as under Alternative 2 (short-term or long-term, minor, and adverse and short term, negligible, and adverse from smoke).

The effects of Alternative 3 on public health and safety would be slightly detectable when combined with the minor to moderate cumulative beneficial impacts from past, present, and future actions, and would result in a continuation of cumulative impacts at that level.

Alternative 4

Elk Management

Because the target population range and the rate of population reduction would be similar to that of Alternative 3, the risk posed by the elk population and its management would be similar. Effects on health and safety as a result of research activities would be the same as described in Alternative 2.

One new source of risk for staff would be handling elk targeted for fertility control treatment and research purposes. Current technology requires capturing and handling elk because remote delivery of such agents has not been fully developed. Moreover, treated elk may need to receive a long-term mark warning against human consumption of meat if withdrawal time of agent or immobilization drug has not passed or if the fertility control agent isn't regulatory approved. At the least, treated elk would receive a short-term mark to prevent multiple treatments and to identify elk that were subject to the research study.

Use of darts to immobilize elk before fertility control, lethal control, and/or research activities involve risks of accidental injection as well as injury from darts. Precautions for accidental exposure such as keeping the gun unloaded and unpressurized with the safety on until just before use, never pointing the muzzle at others, and securing areas before operations begin can prevent accidental administration to humans of the sedative. Other precautions include never working alone, wearing gloves when loading or handling darts to minimize risk of absorbing agent through the skin or eyes, and having specialized first aid training and kits. Short- and long-term, adverse impacts on health and safety associated with dart gun use and with handling drugged animals would be mitigated by adherence to *Director's Order #77-4: Use of Pharmaceuticals for Wildlife* (NPS 2002a), keeping these impacts at a negligible-to-minor level.

Care would also be important when injecting sedated elk. GonaCon™ would cause sterility in humans for the length of the drug's efficacy (Eismann 2005). Leuprolide, used in humans to treat prostate cancer or endometriosis, can cause side effects such as hot flashes, impotence, temporary infertility, atrophic genitalia, potentially fatal cardiac effects, and serious central nervous system disturbances, and may cause fetal harm when given to pregnant women (Chemical Safety Associates 2000). Standard NPS safety procedures would reduce long-term, adverse impacts on health and safety associated with injecting sedated elk to a negligible-to-minor level.

Risk to hunters consuming meat from treated elk would differ depending on the agent. All elk treated with fertility control not suitable for human consumption would be permanently marked to reduce any risk. These precautions would result in long-term, negligible, adverse impacts on health and safety.

Vegetation Management

The effects on human health and safety from fencing and prescribed burning would be the same as under Alternative 3.

Cumulative Impacts

The existing cumulative public health and safety impacts would continue as described in Alternative 1. The combined effects of past, present, and future plans that would beneficially affect public health and safety and the adverse effects of current and future conditions on staff

safety would continue to result in long-term, minor to moderate, beneficial cumulative impacts on public health and safety.

Alternative 4 would result in increased risks to employee safety from the increased amount fence that would be installed and from the handling of elk during fertility control operations. However, when combined with the cumulative impacts of past, present, and future actions, the cumulative impacts of Alternative 4 would be the same as Alternative 2.

Conclusion

The target population range and the rate of population reduction would be similar to that of Alternative 3, and the risk posed by the elk population and management and reduction activities would be similar. Use of darts and handling of drugged animals during fertility control, lethal reduction, or research activities would have short- and long-term, adverse impacts on health and safety would be mitigated by adherence to *Director's Order #77-4: Use of Pharmaceuticals for Wildlife* (NPS 2002a) to a negligible level. With observing standard precautions, risks of consuming meat from treated elk would be reduced, the long-term, adverse impacts on health and safety to a negligible-to-minor level.

The effects on human health and safety from fencing and prescribed burning would be the same as under Alternative 3: short-term (for individual operations) or long-term (the life of the plan), minor, and adverse. Adverse impacts on public health and safety due to smoke would be short term and negligible.

The effects of Alternative 4 on public health and safety would be slightly detectable when combined with the minor to moderate cumulative beneficial impacts from past, present, and future actions, and would result in a continuation of cumulative impacts at that level.

Alternative 5

Because the effectiveness of wolves as an elk management tool would increase gradually under the phased approach, lethal elk reduction by NPS staff or their authorized agents would augment wolf activities. To approximate conditions in a complete ecosystem, elk populations would be allowed to vary between 1,200 and 2,100 individuals. The use of lethal reduction in the first four years to supplement the activities of wolves would result in impacts similar to those under Alternative 2.

Risks during wolf release activities would be associated with constructing holding pens and handling areas, handling wolves during captivity, and monitoring and tracking wolves after release. Safety procedures would be developed from those at other areas that have released wolves. For example, attached holding areas could allow separating individual wolves, as for veterinary treatment, reducing risks to handlers while minimizing potential for habituation. In addition, the holding area could be closed to the public and marked to prevent unauthorized entry.

Park staff would monitor wolves' behavior, removing individuals that showed signs of habituation toward humans. The probability of such behavior is remote: no human deaths have been attributed to wild, healthy wolves in the 20th century, and attacks or bluff charges are rare enough to be reported in scientific journals (McNay 2002). A person is more likely to die from a lightning strike, bee sting, or car collision with a deer than to be injured by a wolf (International Wolf Center 2002). There have been 21 attacks on humans by healthy wolves in North America in the 20th century (International Wolf Center 2003), eight of them between 1982 and 2001 (Linnell et al. 2002). Eighteen of these attacks were by habituated wolves, and in the other three,

humans were protecting their domestic dogs that they had taken into wolf territory (International Wolf Center 2003).

Proper wolf management can greatly reduce any threat that wolves present to humans. Banff and Jasper in Alberta, Canada, are among towns where wolves and humans peacefully coexist (Parsons 2004). Because habituation is the most common factor in wolf attacks on humans, Wyoming's wolf management plan emphasizes educating the public about the importance of not feeding wolves (Wyoming Game and Fish Department 2003). The International Wolf Center offers the following precautions for individuals who view wolves in the wild (2002):

Do not feed wolves.

Do not entice wolves to come closer.

Do not allow a wolf to approach closer than 300 feet.

Do not approach wolves.

Leave room for a wolf to escape.

With wolf management and public education, long-term, adverse impacts on health and safety would be negligible.

Elk Management

NPS staff or their authorized agents would use lethal elk removal to augment the effects of wolf predation on the population; the impacts on public health and safety as a result of elk management actions and research activities would be similar to those under Alternative 2.

As elk seek refuge from wolf predation, they often approach or enter areas frequented by humans because wolves generally avoid such areas. In the park, these would include campgrounds, visitor centers, and other areas with high concentrations of people. Experience in Banff National Park suggests that elk would also use nearby towns, such as Estes Park, as a refuge. Elk would be fewer in number, but the potential would be greater for movement to areas outside the park such as into the Town of Estes Park. Even so, the total number of elk in town could decrease because of a lowered overall elk population, even if elk move out of the park in response to wolves. Some elk may become conditioned by the presence of wolves and exhibit greater wariness and wildness, thus possibly presenting more erratic behavior around humans. The impact of human-elk interactions outside of the park would be negligible. Indirectly the presence of wolves to manage the elk population may cause an increase in mountain lion occurrence in areas outside of the park. Adverse impacts on health and safety in Rocky Mountain National Park would be negligible-to-minor in the long term (the life of the plan) and the short term (individual conditioning sessions).

Vegetation Management

The effects on human health and safety from prescribed burning and mechanical thinning would be the same as under Alternative 2.

Cumulative Impacts

The existing cumulative public health and safety impacts would continue as described in Alternative 1. The combined effects of past, present, and future plans that would beneficially affect public health and safety and the adverse effects of current and future conditions on staff

safety would continue to result in long-term, minor to moderate, beneficial cumulative impacts on public health and safety.

Alternative 5 would result in increased risks associated with the wolf release activities including constructing holding pens and handling areas, handling wolves during captivity, and monitoring and tracking wolves after release as well as increased risk to visitors who attempt to approach wild animals. However, when combined with the cumulative impacts of past, present, and future actions, the cumulative impacts of Alternative 5 would be the same as those of Alternative 2.

Conclusion

Lethal control activities and research activities would result in short- and long-term, adverse impacts on employee health and safety at a negligible to minor intensity. Reduced elk numbers, concentrations, and habituation in combination with aversive conditioning activities would reduce encounters to the lowest level among the alternatives and result in a long-term, negligible to minor, beneficial impact on health and safety. The use of a capture facility for lethal reduction and research activities would result in adverse impacts on health and safety that would be short-term and negligible to minor. Herding or bait lines would be needed to get elk to the facility and would result in long-term, negligible-to-minor, adverse impacts.

Risks during wolf release activities would be associated with constructing holding pens and handling areas, handling wolves during captivity, and monitoring and tracking wolves after release; adverse impacts would be minor in intensity. With wolf management and public education, long-term, adverse impacts on health and safety would be negligible.

As elk seek refuge from wolf predation, they often approach or enter areas frequented by humans. Long- and short-term adverse impacts on health and safety would be negligible-to-minor in campgrounds, visitor centers, and other areas with high concentrations of people. There would be fewer elk, but the potential would be greater for movement to areas outside the park, such as into the Town of Estes Park. The number of elk in town may decrease because of overall smaller elk population, even if elk move out of the park in response to wolves. The impact of human-elk interactions outside of the park would be negligible.

The effects on human health and safety from fencing and prescribed burning would be the same as under Alternative 3: short-term (for individual operations) or long-term (the life of the plan), minor, and adverse. Adverse impacts on public health and safety due to smoke would be short term and negligible.

The effects of Alternative 5 on public health and safety would be slightly detectable when combined with the minor to moderate cumulative beneficial impacts from past, present, and future actions, and would result in a continuation of cumulative impacts at that level.

VISITOR USE AND EXPERIENCE

Summary of Regulations and Policies

Management Policies (NPS 2006b) section 8.2 states that the enjoyment of park resources and values by the people of the United States is part of the fundamental purpose of all park units and that the National Park Service is committed to providing appropriate, high-quality opportunities for visitors to enjoy the national parks. Because many forms of recreation can take place outside of a national park setting, the National Park Service therefore seeks to:

> Provide opportunities for forms of enjoyment that are uniquely suited and appropriate to the superlative natural and cultural resources found in a particular park unit.
>
> Defer to others to meet the broader spectrum of recreational needs and demands that do not depend on a national park setting. Those others can include local, state, and other federal agencies; private industry; and nongovernmental organizations.

Part of the purpose of the national parks is to provide for public outdoor recreation use and enjoyment. Goals for visitor experience provided in the NPS *Strategic Plan* for 2000 through 2005 (NPS 2001h) include:

> NPS Mission Goal IIa**:** Visitors safely enjoy and are satisfied with availability, accessibility, diversity, and quality of park facilities, services, and appropriate recreational opportunities.
>
> NPS Mission Goal IIb: Park visitors and the general public understand and appreciate the preservation of parks and their resources for this and future generations.

Implementation of this policy must meet the Organic Act's requirement that the park service conserve the scenery, natural and historic objects, and wildlife to leave them unimpaired for the enjoyment of future generations.

Management Policies also specifies that visitor activities appropriate to the park environment will be encouraged, whereas those that would impair park resources or are contrary to the purposes for which the park was established will not be permitted.

Section 8.4 of NPS *Management Policies* mandates that all necessary steps be taken to avoid or mitigate adverse effects from aircraft overflights to reduce adverse effects on resources and visitor enjoyment.

Any closures or restrictions, other than those imposed by law, must be consistent with applicable laws, regulations, and policies, and (except in emergency situations) require a written determination by the superintendent that such measures are needed for any of the following reasons:

> Protect public health and safety,
>
> Prevent unacceptable impacts on park resources or values,
>
> Carry out scientific research,
>
> Minimize visitor use conflicts, or
>
> Otherwise implement management responsibilities.

Methodologies and Assumptions for Analyzing Impacts

This impact analysis examines whether the management of elk and vegetation under each management alternative would be compatible with desired visitor experience goals and the purpose of the park as identified in the enabling legislation and in other laws and policies affecting visitor use.

To determine the effects of the alternatives on visitor experience, each issue was evaluated using the procedures described in the "General Methodologies" section near the beginning of this chapter. This impact analysis evaluates several aspects of visitor experience, including visitor perceptions of elk in and near the park, perception of vegetation in the park (including during the autumn "leaf season"), access to park resources, and understanding and appreciating park values. Professional judgment based on visitor surveys and informal interactions between visitors and park staff was used to reach reasonable conclusions as to the intensity and duration of potential impacts.

Area Evaluated

The geographic area evaluated for impacts includes Rocky Mountain National Park and nearby areas where park visitors go, including the town of Estes Park and U.S. Forest Service land.

Issues

Issues identified during internal and public scoping that relate to how alternative management approaches may affect visitor use and experience include:

Elk viewing is a popular activity within the park and is an important reason why many visitors come to the park, especially during the rutting season.

The natural and unaltered landscape of the park is an important component of visitors' experience. Structures and physical intrusions, such as fences, can detract from the viewshed and adversely affect the quality of the park experience.

Easy access to areas where elk congregate is provided by park roads and within park developed areas and enhances opportunities to view elk.

Visitor congestion and noise can be high in popular elk viewing areas and detract from the national park experience.

Noise associated with lethal control activities can intrude on visitors' experience and disrupt feelings of quiet and solitude.

The use of weapons for lethal reduction activities, dart guns for fertility control and research activities, and redistribution devices may be perceived as threats to visitor safety.

Many members of the public feel that lethal methods to reduce wildlife populations are unethical.

Prescribed burning can generate, noise, smoke, and odors, and can require closure of burn areas to visitors' use, which can detract from the park experience.

Impact Threshold Definitions

Intensity of Impacts

The following threshold definitions were applied to determine elk and vegetation management effects on visitor use and experience.

Negligible: Visitors would not be affected, or changes in visitor experience or understanding would be below or at the level of detection. Visitors would not likely be aware of the effects associated with the alternative.

Minor: Changes in visitor experience or understanding would be detectable, although the changes would be slight. Visitors could be aware of effects associated with the alternative, but only slightly.

Moderate: Changes in visitor experience or understanding would be readily apparent. Visitors would be aware of the effects associated with the alternative and would likely be able to express an opinion about the changes.

Major: Changes in visitor experience or understanding would be readily apparent and would have important consequences. Visitors would be aware of the effects associated with the alternative and would likely express a strong opinion about the changes.

Type and Duration of Impact

Beneficial impacts would improve visitor enjoyment and recreational or educational opportunities.

Adverse impacts would diminish visitor enjoyment and recreational or educational opportunities.

Duration: With short-term impacts, effects on visitor enjoyment and recreational or educational opportunities would persist for less than one year. With long-term impacts, effects on visitor enjoyment and recreational or educational opportunities would persist for one year or more.

Alternative 1

Elk and Wildlife Viewing and Natural Park Experience

Because elk in and around the park would remain plentiful and habituated, visitors would continue to have abundant opportunities to view elk, often from the convenience of their cars. This condition would continue to provide a moderate-to-major benefit over the long term, particularly for those who visit the park during rutting season to observe bugling, challenges, and other mating rituals from the bulls.

However, roads through large meadows where elk congregate would continue to attract large numbers of visitors, many of whom park along the roadside to watch. High visitor concentrations require traffic control and crowd management by park staff and volunteers, somewhat diminishing the enjoyment for all visitors viewing elk. In addition, the numerous parked or slow cars interfere with traffic flow, inconveniencing drivers who are trying to get through. Some visitors complain that the mood in September and October is more that of a tailgate party than a natural experience, with picnics and viewing platforms all too common. These effects would continue to cause moderate-to-major, adverse impacts over the long term on individual visitors who prefer a lower human density during their park experiences.

Visitors who prefer to view the park's wildlife under more natural conditions would instead be more likely to observe animals that have become habituated to the presence of large numbers of humans. Viewing opportunities for species that depend on habitat over-foraged by elk – such as deer, beaver, riparian songbirds, and some butterflies – decline with the unnaturally high elk population, resulting in a negligible-to-moderate, long-term, adverse impact on park visitors interested in viewing wildlife.

Visitors are also increasingly aware of the effects on aspen and willow of over-browsing by elk, particularly in Moraine Park, Horseshoe Park, and Upper Beaver Meadows on the east side of the park and Kawuneeche Valley on the west side (Ronca 2005d). Among some visitors, this causes concern that elk may starve. The over-browsing also slightly degrades fall foliage viewing in the park. As impacts on aspen and willows from elk over-browsing continue, those visitors who are aware of the condition of vegetation on the primary winter range or wish to view the fullest display of fall foliage would experience minor-to-major, long-term, adverse effects. For the overall visitor population, the effect would be minor and adverse.

Fencing

Experimental fencing to protect selected aspen communities has led to questions from visitors about the purpose of fences in otherwise natural-appearing areas. Cordova's survey found visitors to be fairly evenly divided in their opinions on the acceptability of such fencing for vegetation management (2000b). Fix and Stewart three years later found similar attitudes, with support for fencing ranging from 40% to more than 60% (2003). Fences would continue to be limited to several small research exclosures in scattered locations within the park. The studies suggest that continuation of current and foreseeable future levels of fencing would result in a negligible, long-term, adverse impact on visitors' experiences.

Aerial Activity

The use of helicopters for park resource monitoring would continue and occur for a probable total of four to six hours annually. Experiencing the short-duration noise and presence of aerial operations would continue to result, depending on the distance from the helicopter, in negligible-to-major, short-term, adverse impacts on visitors' experience, including visitors to the backcountry may experience short-term, moderate-to-major, adverse impacts.

Cumulative Impacts

Rocky Mountain National Park is one of the most popular parks in the national park system. Since 1984, when visitor counting procedures improved, visitation to Rocky Mountain National Park has grown fairly steadily from 2.2 million to 3.2 million where it has remained stable.

Visitors are positively affected by a wide range of opportunities and facilities within the park. Visitors engage in popular activities include viewing wildlife and scenery, hiking, backpacking, and horseback riding on nearly 360 miles of trails; fly fishing, bird watching, and photography. Campers have nearly 600 sites accessible by car, while backcountry visitors have another 208 sites available. In 2004, car-accessible campgrounds hosted 153,855 visitors, and backcountry campgrounds hosted 26,522 (NPS 2005f). Other popular park facilities include the park's five visitor centers and museums; the Kawuneeche Visitor Center, the Alpine Visitor Center, the Beaver Meadows Visitor Center, the Moraine Park Museum, and the Lilly Lake Visitor Center.

Conditions also exist in the park that result in adverse impacts on visitor experience. High levels of visitation to national parks results in crowding, dissatisfaction, and displacement of visitors to

other parks or recreation opportunities (Gramann 2002). In Rocky Mountain National Park conditions exist that indicate a portion of park visitors are dissatisfied with the levels of use experienced in the park (NPS 2002d). Other activities have the potential for adversely affecting visitor experience including overflights by commercial aircraft from Denver International Airport, park search and rescue and resource management aircraft use, and snowmobile use on the west side of the park. These conditions can have long-term, minor-to-moderate, adverse impacts on visitor experience.

The park manages the impacts of these conditions through the development of management plans and implementation of subsequent actions to improve the experience of visitors. Past and future management plans that affect visitor use and experience include the snowmobile management plan (NPS 2002b), the commercial services plan (NPS 1999c), the commercial horse use plan (NPS 1994), and the backcountry and wilderness management plan including the use of minimum tool analysis (NPS 2001a), the second phase of the reconstruction of the Bear Lake Road, and the Highway 7 corridor management plan slated to start in 2006. These plans and actions have altered or will alter conditions, with adverse effects on visitor experience, and have long-term beneficial effects on visitor experience that range from minor to moderate in intensity.

The overall satisfaction of visitors was measured in 2002 with the Visitor Survey Card survey for the 12 national parks in the Rocky Mountain Cluster, including Rocky Mountain National Park (NPS 2002d). Ninety-five percent of park visitors are satisfied overall with appropriate facilities, services, and recreational opportunities. The benefits of opportunities and facilities at Rocky Mountain National Park are readily apparent to visitors, and their positive opinions, combined with past and future actions of the park to manage park conditions, indicate a long-term, moderate, beneficial, cumulative impact on visitor experience.

Alternative 1 would continue to provide benefits because the distribution and numbers of elk would not be likely to change, and the positive contribution of elk to the visitor experience would not change. Elk would continue to be a draw for a substantial number of visitors. Localized crowding in elk viewing areas would continue. Vegetation within the primary winter and summer ranges would continue to be degraded. Existing small areas of fencing and monitoring activities would continue. The continuation of current management and the beneficial and adverse effects of Alternative 1 would contribute to the long-term, moderate, cumulative benefits to visitor use and experience.

Conclusion

Opportunities to view elk would continue to provide a moderate-to-major benefit over the long term. High concentrations of visitors viewing elk would cause moderate-to-major, adverse impacts over the long term for visitor preferring less crowding; minor-to-moderate for others. Visitors who prefer to view the park's wildlife under more natural conditions would experience negligible-to-moderate, long-term, adverse impacts. Impacts on aspen and willows from elk over-browsing would continue to cause minor-to-major, long-term, adverse effects on visitors who are aware of the conditions. For the overall visitor population, the effect would be minor and adverse. Experimental fencing to protect selected aspen communities would result in a negligible, long-term, adverse impact on visitors' experiences. The use of helicopters for park resource monitoring would result in negligible-to-major, short-term, adverse impacts, depending on the distance from the helicopter. The continuation of current management and the beneficial and adverse effects of Alternative 1 would contribute to the long-term, moderate, cumulative benefits to visitor use and experience.

Alternative 2

Elk and Wildlife Viewing and Natural Park Experience

Fewer elk that are more wary of humans would somewhat reduce viewing opportunities in the park, including at the large meadows bisected by the main roads. Despite this reduction, visitors would continue to have many opportunities to view elk, including during the fall rutting season. The numbers of elk visible at any given time would probably be less than under current management, but elk would continue to be seen congregating in open meadows. The park would monitor visitation patterns and visitor responses to changes in elk numbers and distribution, particularly during the fall rut, and could modify treatment as appropriate. The adverse impacts on visitors who visit the park with an interest in viewing elk would be negligible to minor over the long term.

Visitors' likelihood of experiencing elk would be reduced slightly, but should not affect visitor draw because bugling and rutting in the fall would occur in the same locations as under Alternative 1. Crowds viewing elk from park roadsides would not be substantially reduced. Impacts on visitor experience from crowding would be negligible, long-term, and beneficial.

With improved willow and aspen communities, visitors would have the opportunity to see elk in a setting closer to natural conditions, and visitors would also have more opportunity to see other wildlife, such as deer, beaver, riparian songbirds, and some butterflies, that depend on the forage and habitat currently over-browsed by elk. The net effect for those who prefer to view elk and other wildlife in a relatively natural setting would be minor, long term, and beneficial. For most visitors the beneficial impact would be negligible to minor.

The return of plant communities would result in a minor, long-term benefit, including improved fall colors for visitors who are aware of the improvements.

Reduction Activities

NPS staff and their authorized agents would use lethal methods to reduce the elk population to a target range that would allow restoration of over-browsed vegetation, especially aspen, willow, and upland shrub communities. Firearms use can disturb the natural soundscape that many visitors expect in the park (as discussed in the "Soundscape" section) and may cause visitors to be concerned for their personal safety (as discussed in the "Public Health and Safety" section).

Lethal reduction actions would be conducted in a manner that would minimize impacts on visitor use and experience. Mitigations would include varying the type of weapon or the times of day when actions occur. Adverse impacts on visitors' experience would be short term and moderate during the first four years of the plan reduced to minor in the last 16 years as the frequency of lethal reduction activities decreases. Education through displays and brochures and interpretation by park staff could prevent unrealistically high visitor perception of risk. When firearms with noise suppression and subsonic ammunition are used the impacts could further be reduced to a negligible level; anyone more than 50 yards away would be unlikely to notice anything.

Some visitors may have ethical concerns about the use of lethal control on elk. For those individuals, the knowledge and awareness of the National Park Service's actions would have an adverse effect ranging from minor to major, depending on the individual's sensitivity and ethical perspective. Some members of the public could have a negative perception of lethal reduction activities that could result in choosing not to visit the park, with up to a 5% decrease in visitation during the first four years of the plan. There would be negligible, adverse, long-term effect on visitation with improved education and interpretation.

A capture facility could be used inside the park if remote firearms use proved inadequate to reach population reduction targets, particularly during the first four years of high-intensity operation. Seeing the facility could have a minor adverse effect on some visitors by diminishing the sense of wildness or by associations with death. Individual visitors who may inadvertently witness capture facility and lethal reduction activities could have adverse, short-term, effects from moderate to major. Closing the area to visitors would minimize such effects, but would inconvenience those visitors who planned to pass through or use the area. Therefore, areas not frequented by the public, such as Little Horseshoe Park, could provide the preferred locations for a capture facility, if needed.

Area closures for lethal elk reduction would prevent access during operations, creating short-term inconveniences for visitors who planned to use those areas for recreation activities such as hiking, horseback riding, or photography. Performing operations at night or in low-use seasons would minimize such effects. The potential for closures would be greater in the first four years of the plan when operations to reduce the elk population would be more intense. As a result, there would be minor short-term adverse effects on visitor use and experience as a result of inconveniences caused by area closures. During the remaining 16 years of the plan when lethal reduction activities would be less frequent, the short-term adverse effects would be reduced to negligible to minor. By providing adequate information to visitors about closed areas and the reasons for closures, visitors would be able plan alternate trip destinations and understand the reasons for doing so.

Aerial activity associated with monitoring would occur throughout the 20-year plan. In addition, this alternative could involve the adaptive use of helicopters for elk management activities. A helicopter could be used for herding and carcass removal if necessary for disease management concerns. This would be more likely to occur during the first four years of the plan and the use of helicopters for elk population management would decrease in the remaining 16 years of the plan as the number of elk to be removed would be much less. Noise resulting from aerial activity would have negligible-to-major, short-term, adverse impacts on visitor experience from the intrusion of noise, vibration, and visibility of helicopters in a national park setting. The intensity of the impact would depend on the distance from the helicopter, and would occur periodically throughout the life of the plan.

Fencing

Fencing to protect up to 160 acres of aspen stands could be installed. Therefore, adverse impacts associated with fence installation and maintenance under this alternative would be minor to moderate over the long term, particularly in areas where fences can not be screened by landscape features such as hills or vegetation. Individual visitors would experience a localized, moderate-to-major adverse impact, but this would vary depending on the ability of visitors to see the fence or if hiking were to be interrupted by a fence and gate. Where helicopters are used to transport fence material to off-road areas, visitors would experience short-term, negligible-to-major adverse impacts, as described above.

Prescribed Fire

The use of prescribed burns to stimulate growth of aspen and willows could alarm or bother visitors who observe smoke or flames. Noise associated with machinery used for burn control or other mechanical treatment of vegetation could detract from the experience of visitors expecting a near-natural soundscape. Mitigation could include education programs explaining such activities,

including what the treatments accomplish and, when possible, advance warning to help visitors plan. As a result, associated short-term adverse effects would be negligible to minor.

Research Activities

A research study evaluating procedures for a live test for chronic wasting disease in elk would be conducted in coordination with elk management activities in the first three years of the plan. Effects on visitor use and experience from the capture or darting, anesthetizing, and handling of elk would be the same as those described above for reductions activities involving the management of elk with firearms and access restrictions.

The three-year research study could affect visitor use and experience as a result of elk being marked or tagged and fitted with radio-collars. Some park visitors may feel that seeing wildlife with human-made marks or collars diminishes the viewing experience, and the sense of viewing wild animals would experience minor, adverse effects over the short term.

Cumulative Impacts

The existing cumulative visitor use and experience impacts would continue as described in Alternative 1. The benefits of opportunities and facilities at Rocky Mountain National Park are readily apparent to visitors, and their positive opinions, combined with past and future actions of the park to manage park conditions, indicate a long-term, moderate, beneficial, cumulative impact on visitor experience.

Alternative 2 would reduce the number of elk as a result of lethal reduction activity; the intrinsic value of the elk experience would likely remain unchanged. In the short term, visitation would decrease due to the adverse impacts of lethal reduction activities and ethical concerns of some people, but long-term visitation would not be affected, and adverse impacts would be negligible. The condition of affected plant communities would improve, including improved fall colors. The presence of fences to protect up to 160 acres of aspen would adversely affect visitor experience. The adverse effects of other actions within Alternative 2 would be negligible to minor.

Over the total visitor population and over all seasons, the beneficial and adverse effects of Alternative 2 would probably be slightly measurable as expressed by the Visitor Survey Card survey. The adverse effects of elk reduction activities and fencing would be most measurable, and the adverse effects on the cumulative visitor experience in the park would be minor and long-term. The beneficial effects from vegetation improvements would have a negligible, long-term effect. There would be little or no change in the park's cumulative impacts on visitor use and experience, and impacts would continue to be moderate, long term, and beneficial.

Conclusion

Fewer elk that are more wary of humans would somewhat reduce viewing opportunities in the park, but visitors would continue to have many opportunities to view elk, and the adverse impacts on visitors who visit the park with an interest in viewing elk would be negligible to minor over the long term. Impacts on visitor experience from crowding would be negligible, long term and beneficial. The net effect for those who prefer to view elk and other wildlife in a relatively natural setting would be minor, long term, and beneficial. For most visitors the beneficial impact would be negligible to minor. The return of plant communities would result in a minor, long-term benefit, including improved fall colors for visitors who are aware of the improvements.

Lethal control would result in adverse impacts on visitors' experience that would be short term moderate in the first four years of the plan and reduced to minor in the last 16 years. A capture facility could be used inside the park. Seeing the facility could have minor adverse effect on some visitors. Some visitors may have ethical concerns; for them, actions involving a capture facility and lethal control would have an adverse effect ranging from minor to major, depending on the individual's sensitivity and ethical perspective.

The adverse impacts on visitors as a result of closures during lethal elk reduction activities would be short-term and minor in the first four years of the plan reduced to negligible to minor in the remaining 16 years. Aerial activity associated with monitoring, management of elk, or fence installation would produce negligible-to-major, short-term, adverse impacts on visitors' experience. Use of fences to protect up to 160 acres of aspen would cause a long-term, local, minor-to-major, adverse impact, which would vary depending on the ability of visitors to see the fence. The use of prescribed burns to stimulate growth of aspen and willows would cause negligible to minor, short-term, adverse impacts.

The effects of firearms use to dart elk and handling of elk for research activities would be the same as for lethal reduction activities. Marking of elk for research purposes would have short-term, minor, adverse effects.

Overall there would be little or no change in the park's cumulative impacts on visitor use and experience and impacts would continue to be moderate, long-term, and beneficial.

Alternative 3

Elk and Wildlife Viewing and Natural Park Experience

Effects on visitors due to management of the elk population would be similar to those of Alternative 2. However, this approach would achieve target numbers more gradually, and the overall reduction would be less than Alternative 2. Visitors would therefore be less likely to notice elk management activities or effects. By the end of the plan, visitors would experience a similar environment in both alternatives, and the adverse impacts on visitors' experience would be negligible.

Crowds viewing elk from park roadsides would not be substantially reduced. Impacts on visitor experience from crowding would be similar to Alternative 2.

Viewing opportunities for other wildlife and opportunities to view wildlife in a relatively natural setting would be similar to opportunities under Alternative 2.

The return of plant communities and the benefits to visitors' experience would be similar to Alternative 2.

Reduction Activities

The effects of lethal reduction activities on visitors' experience would be similar to those during the maintenance phase (or last 16 years) of Alternative 2. The impacts would be short-term and minor to moderate.

A capture facility could be used adaptively if other methods of lethal reduction are not effective. The effects would be the same as in Alternative 2.

The effects of area closures would be similar to the the last 16 years of Alternative 2. Adverse impacts would be short-term and negligible to minor.

Aerial activity associated with monitoring or management of elk would be similar to Alternative 2.

Fencing

The effects of aspen fencing would be similar to those under Alternative 2.

Willow fence would be more visible than aspen fence, and the likelihood of seeing fences and the number of people that could see a fence would increase. Fencing would detract from the natural appearance and intrude on features, such as streams and trails, important to many visitors, diminishing the park's reputation. Fencing to protect willow habitat would be pervasive in areas of the primary summer and winter ranges, with up to 440 acres fenced. Much of this area would coincide with areas of high visitor use, including Moraine Park, Horseshoe Park, and the Kawuneeche Valley. Willow fencing would be more visible than aspen fencing. Efforts would be employed to minimize to the extent possible visual impacts through the design of the fence and selection of materials. In addition fences would be designed to allow for public access to enclosed areas via gates. Individual visitors would experience a localized, major adverse impact, but this would vary depending on the ability of visitors to see the fence or if hiking or use of an area were to be interrupted by a fence and gate.

The large amount of fencing to be installed may require more helicopter trips into off-road areas to haul heavy materials. If the maximum amount of fencing is installed, it would result in negligible-to-major, short-term, adverse impacts on visitor experience, as described in Alternative 2, but would occur more frequently throughout the life of the plan.

Prescribed Fire

The effects of prescribed fire would be the same as under Alternative 2, however, they would be realized more quickly in the plan implementation because increased fences would enable prescribed fire to be used sooner.

Research Activities

The capture or darting, anesthetizing, and handling of elk during research activities conducted in coordination with elk reduction activities would have similar effects on visitor use and experience as those described above for reduction activities involving the management of elk with firearms and access restrictions.

The three-year research study could affect visitor use and experience as a result of elk being marked or tagged and fitted with radio-collars and as a result of some animals being treated with a fertility control agent to evaluate drug effectiveness. Some park visitors may feel that seeing wildlife with human-made marks or collars diminishes the viewing experience, and the sense of viewing wild animals would experience short-term, minor, adverse effects over the short term. Elk behavior of those subject to the fertility control study would not be altered by fertility treatments; therefore, this would have no observable effect on visitor use and experience.

Cumulative Impacts

The existing cumulative visitor use and experience impacts would continue as described in Alternative 1. The benefits of opportunities and facilities at Rocky Mountain National Park are readily apparent to visitors, and their positive opinions, combined with past and future actions of

the park to manage park conditions, indicate a long-term, moderate, beneficial, cumulative impact on visitor experience.

Alternative 3 would have similar cumulative effects as those in Alternative 2, including lethal reduction activities, elk viewing, vegetation condition, and monitoring. Up to 600 acres of habitat fenced would result in major adverse impacts, and would affect visitor experience in all seasons. The effects would be localized to the primary winter and summer ranges of elk, and most the park would not be affected. The effect on overall visitor satisfaction would be expected to be only slightly measurable by the Visitor Survey Card survey. Overall, the cumulative impact on visitor use and experience from conditions within the park would continue to be moderate, long term, and beneficial.

Conclusion

Lethal control activities would have adverse impacts on visitors' experience that would be short-term and of minor intensity. Effects on visitors due to management of the elk population would be similar to those of Alternative 2, including impacts on visitor experience from crowding, viewing opportunities for other wildlife and opportunities to view wildlife in a relatively natural setting, and the return of plant communities.

A capture facility could be adaptively for lethal control of elk Seeing the facility could have minor adverse effect on some visitors. Some visitors may have ethical concerns; for them, actions involving a capture facility and lethal control would have an adverse effect ranging from minor to major, depending on the individual's sensitivity and ethical perspective.

The effects of area closures would be similar to those described under Alternative 2 for the last 16 years of the plan. The adverse impacts would be negligible to minor. Aerial activity associated with monitoring or management of elk as an adaptive tool would be similar to Alternative 2. If the maximum amount of fencing is installed, aerial activity would have similar impacts as Alternative 2, but they would occur more frequently throughout the life of the plan.

Fencing up to 600 acres of habitat to protect aspen and montane riparian willow would result in major adverse impacts. The effects of prescribed fire would be the same as under Alternative 2: short-term, negligible to minor, and adverse.

The effects of use of firearms to dart elk and handling of elk for research activities would be the same as for lethal reduction activities. Marking of elk and treatment with fertility control agents for research purposes would have short-term, minor, adverse effects on visitor experience.

Overall, the cumulative impact on visitor use and experience from conditions within the park would continue to be moderate, long-term, and beneficial.

Alternative 4

Elk and Wildlife Viewing and Natural Park Experience

Visitor opportunities to view elk and the impact on visitors' experience, including crowding, and viewing opportunities for other wildlife would be the same as under Alternative 3.

The return of plant communities and the benefits to visitors' experience would be similar to Alternative 2.

Reduction Activities

Both lethal reduction and fertility control methods would be used under this alternative. The intensity and type of reactions to the two management tools would vary across individuals. A poll in California found that 35% of respondents supported lethal control of ungulates, while 65% supported contraception, suggesting that the experience of more visitors could be adversely affected by lethal control than by fertility control (NPS 2004c). In a 1999 survey in Rocky Mountain National Park, fertility control as an elk management tool received support among 22.2% of visitors surveyed, roughly equivalent to the 21.3% who supported lethal control (Cordova 2000b).

Elk treated with a fertility control agent would receive a short-term mark, such as from a paintball, to prevent multiple treatments. Treated elk may also need to receive a long-term mark readily recognizable by hunters (perhaps ear tags or freeze brands with the warning, "Do Not Consume") to prevent human consumption of meat if the drug is not regulatory-approved agent or the withdrawal time of the agent has not passed. Those hunters outside the park could experience minor, adverse impacts over the long term from such warnings. Some park visitors may feel that seeing wildlife with human-made marks or collars diminishes the viewing experience and the sense of viewing wild animals would experience minor, adverse effects over the long term. If fertility control methods need to be substantially augmented with lethal control activities to meet population targets, the effects would be similar to Alternative 3. The adverse visual effects of fertility control markings or collars could reduce their attractiveness of elk to visitors during the rutting season. This could result in some people choosing not to visit the park and up to a 10% decrease in visitation during the first four years of the plan. There would be reduced long-term adverse effect on visitation with improved education and interpretation.

A capture facility could be used to treat elk with fertility control and mark as necessary. Impacts would be the same as under Alternative 2.

The effects of area closures would be similar to those described for Alternative 3; short-term, adverse, and negligible to minor.

Aerial activity associated with monitoring or management of elk would be the same as Alternative 2.

Fencing

Adverse impacts associated with fence installation and maintenance would be the same as under Alternative 3.

Prescribed Fire

The effects of prescribed fire would be the same as under Alternative 2.

Research Activities

The capture or darting, anesthetizing, and handling of elk during research activities conducted in coordination with elk reduction activities would have similar effects on visitor use and experience as those described above for reductions activities involving the management of elk with firearms and access restrictions.

Tagging or marking elk and the use of fertility control agent for research purposes would have the same effect on visitors experience of the park and viewing wildlife as described above in this alternative.

Cumulative Impacts

The existing cumulative visitor use and experience impacts would continue as described in Alternative 1. The benefits of opportunities and facilities at Rocky Mountain National Park are readily apparent to visitors, and their positive opinions, combined with past and future actions of the park to manage park conditions, indicate a long-term, moderate, beneficial, cumulative impact on visitor experience.

Alternative 4 would have similar cumulative effects as in Alternative 3 for lethal reduction activities, elk viewing, vegetation conditions, fencing, and monitoring. Fertility control activities would have adverse effects on visitor experience; however, given the level of acceptability of fertility control as identified in research cited above, the effect on the cumulative visitor experience would be negligible. Overall, the cumulative impact on visitor use and experience from conditions within the park would continue to be moderate, long-term, and beneficial.

Conclusion

Lethal control activities would have short-term, minor, adverse effects on visitors' experience. Visitor opportunities to view elk and the impact on visitors' experience, including crowding, would be the same as under Alternative 3: negligible to minor over the long-term. Viewing opportunities for other wildlife and opportunities to view wildlife in a relatively natural setting would be similar to opportunities under Alternative 2: negligible to minor, long term, and beneficial. The return of plant communities and the benefits to visitors' experience would be similar to Alternative 2: negligible-to-minor, long-term, and beneficial.

Elk treated with a fertility control agent for population management and research activities would receive a short-term mark, such as from a paintball, to prevent multiple treatments, and possible long-term markings to warn hunters against consumption. Hunters could experience minor, adverse impacts over the long term from such warnings. Human-made marks or collars would diminish the viewing experience, and visitors would experience minor, adverse effects over the long term.

Adverse impacts associated with fences would be the same as under Alternative 3: long-term, major, and adverse. The effects of prescribed fire would be the same as under Alternative 2: short term, negligible to minor, and adverse.

The effects of use of firearms and handling of elk for research activities would be the same as for lethal reduction activities. Marking of elk and treatment with fertility control agents for research purposes would have short-term, minor, adverse effects.

Overall, the cumulative impact on visitor use and experience from conditions within the park would continue to be moderate, long-term, and beneficial.

Alternative 5

In a 1999 survey of park visitors, release of natural predators received the most support as a tool for managing elk, with approval by 67.9% of those surveyed (Cordova 2000b). The presence of wolves could increase visitor perception of wildness and an intact ecosystem, improving the park's reputation (Parsons 2003; International Wolf Center 1999). Park programs could enhance

the experience with programs that interpret wolves and their behavior through a variety of media and activities.

Elk and Wildlife Viewing and Natural Park Experience

Visitor opportunities to view elk would be the same as under Alternative 3 in the early years of the plan and somewhat greater in the later years. Dispersal of elk would be greater, but viewing opportunities in large meadows would be expected to continue as in Yellowstone (Fortin et al. 2005). The beneficial impacts on visitors who visit the park with an interest in viewing elk would be minor over the long term.

Visitors would have the opportunity to see elk and other wildlife in a more natural setting similar to Alternative 2. However, wolves would restructure wildlife populations, and there would be changes in abundance and behavior of other species, such as deer and coyotes, that may make them more difficult to view. There would be an overall negligible-to-minor, long-term, beneficial impact due to improved natural settings, but a negligible-to-minor, adverse impact on the ability of visitors to view certain species affected by wolves.

The presence of wolves could increase visitor perception of wildness and an intact ecosystem, improving the park's reputation. The park would provide interpretive and educational programs that could enhance the experience for visitors by increasing their awareness of and appreciation for conditions in the park. While wolf management techniques, such as collars, could somewhat reduce the perception of wildness, for the visitors who value wolves or a more complete ecosystem, the opportunity to see or hear wolves would provide a long-term, minor-to-moderate benefit. For visitors who fear wolves and would choose not to hike or backpack as a result of wolf presence would experience a long-term, minor to moderate adverse impact.

The presence of wolves in the park and the opportunity to see wolves and their interactions with other wildlife would provide a substantial, long term attraction for visitors, and would result in a potential 10% increase in visitation. Increased visitation and increased probability for crowding, such as at wolf sightings, would result in long-term, minor, adverse impacts on visitor experience.

The return of plant communities and the benefits to visitor experience would be similar to Alternative 2.

Reduction Activities

If emphasis must be placed on lethal reduction over the actions of wolves, the effects on visitor experience would be as similar to those under Alternative 2.

If wolves are effective in reducing elk numbers, there would be minor-to-moderate, long-term, positive impacts on those who perceive wolves to be an ethical and natural method for reducing elk populations.

The impacts associated with an elk capture facility plus holding pens that would be used for the release of wolves would produce impacts similar to Alternative 2.

If there is a greater need for lethal reduction activities, area closures would be more intense in the first four years, and impacts would be similar to Alternative 2.

Aerial activity associated with monitoring or managing elk as an adaptive tool would be similar to Alternative 2; however, the activities associated with monitoring wolf behavior and movement require more helicopter use. This would be mitigated through the use of satellite monitoring rather than overflights.

Fencing

The effects of aspen fencing would be similar to those under Alternative 2.

Prescribed Fire

The effects of prescribed fire in vegetation communities that have been protected from excess grazing would be the same as under Alternative 2.

Research Activities

The capture or darting, anesthetizing, and handling of elk during research activities conducted in coordination with elk reduction activities would have similar effects on visitor use and experience as those described above for reductions activities involving the management of elk with firearms, use of a capture facility, and access restrictions.

Tagging or marking elk for research purposes would have the same effect on visitor use and experience as described in Alternative 2.

Cumulative Impacts

The existing cumulative visitor use and experience impacts would continue as described in Alternative 1. The benefits of opportunities and facilities at Rocky Mountain National Park are readily apparent to visitors, and their positive opinions, combined with past and future actions of the park to manage park conditions, indicate a long-term, moderate, beneficial, cumulative impact on visitor experience.

Alternative 5 would have similar cumulative effects as Alternative 2, including lethal reduction activities (if needed to the maximum extent), elk viewing, and vegetation condition. The presence of wolves could increase visitor perception of wildness and an intact ecosystem, improving the park's reputation and having beneficial effects on cumulative visitor experience. Increased visitation and increased opportunities for crowding, such as at wolf sightings, would have adverse effects but would not likely be measurable in overall park visitor satisfaction. The effects of Alternative 5 would be expected to be measurable by the Visitor Survey Card survey as a contributor to high levels of visitor satisfaction. Overall, however, the cumulative impacts on visitor use and experience from conditions within the park would continue to be moderate, long-term, and beneficial.

Conclusion

Visitor opportunities to view elk would be the same as under Alternative 3 in the early years of the plan and somewhat greater in the later years. Dispersal of elk by wolves would be greater and viewing opportunities in large meadows would increase. The beneficial impacts on visitors who visit the park with an interest in viewing elk would be minor over the long term. Visitors would have the opportunity to see elk and other wildlife in a more natural setting similar to Alternative 2. There would be an overall negligible-to-minor, long-term, beneficial impact due to improved natural settings from wolves' overall impacts on other wildlife, but a negligible to minor, adverse impact on the ability of visitors to view certain species affected by wolves.

The presence of wolves could increase visitor perception of wildness and an intact ecosystem, improving the park's reputation. For the visitors who value wolves or a more complete ecosystem, the opportunity to see or hear wolves would provide a long-term, minor-to-moderate

benefit. For visitors who fear wolves and would choose not to hike or backpack as a result of wolf presence would experience a long-term, minor to moderate adverse impact. Increased visitation and increased opportunities for crowding, such as at wolf sightings, would result in long-term, minor, adverse impacts on visitor experience. The return of plant communities and the benefits to visitors' experience would be similar to Alternative 2: long-term and negligible to minor.

If emphasis must be placed on lethal reduction over the actions of wolves, the effects on visitor experience would be as similar to those under Alternative 2: short-term, minor, and adverse. If wolves are effective in reducing elk numbers and redistributing elk, there would be minor to moderate, long-term, positive impacts on those who perceive wolves to be an ethical and natural method for reducing elk populations and affecting elk movements. The impacts associated with an elk capture facility plus holding pens that would be used for the release of wolves would produce impacts similar to Alternative 2: minor and adverse. If there is a greater need for lethal reduction activities, area closures would be more intense in the first four years, and impacts would be similar to Alternative 2: short-term, adverse, and minor in the first four years of the plan reduce to negligible to minor in the remaining 16 years. Aerial activity associated with monitoring, management of elk as an adaptive tool, or fence installation would be similar to Alternative 2: short-term, negligible to minor, and adverse; however, the activities associated with monitoring wolf behavior and movement would require more helicopter use.

The effects of aspen fencing would be similar to those under Alternative 2: long-term, local, minor to major, and adverse. The effects of prescribed fire would be the same as under Alternative 2: short-term, negligible to minor, and adverse.

The effects of use of firearms and handling of elk for research activities would be the same as for lethal reduction activities. Marking of elk and treatment with fertility control agents for research purposes would have short-term, minor, adverse effects.

The cumulative impacts on visitor use and experience from conditions within the park would continue to be moderate, long-term, and beneficial.

PARK OPERATIONS

Guiding Regulations and Policies

Management Policies (NPS 2006b) gives guidance for the management of natural resources in the parks and how National Park Service staff should accomplish resource management goals through the use of various tools and approaches. It requires that park operations achieve the following conditions:

Park facilities and operations demonstrate the National Park Service's environmental leadership by incorporating sustainable practices to the maximum extent practicable in planning, design, siting, construction, and maintenance, including preventive and rehabilitative maintenance programs.

In regard to the park interpretive staff, Section 7.5.3 of *Management Policies* requires that "parks should, in balanced and appropriate ways, thoroughly integrate resource issues…into their interpretive and educational programs. Resource issue interpretation should be integrated into both on- and off- site programs, as well as into printed and electronic media whenever appropriate" (NPS 2006b). Augmenting the park's interpretive and educational programs to include information about resource management actions can build understanding of, and support for, the National Park Service's resource management decisions and the NPS mission in general. The park interpretive staff must be educated about the reasoning used in the decision-making process and be able to present a balanced view of the rationale.

The Rocky Mountain National Park Habituated Wildlife Standard Operating Procedures direct the actions to be taken in identifying habituated wildlife and in conducting both preventive and reactive resource management activities (NPS 2002e). During any park operations involving redistribution techniques, the administration of pharmaceuticals, destruction of animals, area closures, or marking of treated animals, these standards must be met.

Methodology and Assumptions

Geographic Area Evaluated for Impacts.

The elk population move within their primary winter and summer ranges within Rocky Mountain National Park. Park staff are responsible for their management throughout this area. Vegetation considered in this analysis include aspen and willow in primary winter and summer ranges, including montane riparian willow habitat on the east side of the park. The geographic area of effect of physical activities being evaluated for impacts on park operations are the primary winter and summer elk range within the park. Staff involved in the management of elk- and vegetation-related issues often have park-wide responsibilities that may be affected by elk and vegetation management. For this reason, the area of analysis is park-wide.

Issues

Park staff members from nearly all divisions at Rocky Mountain National Park are affected by the issues created by the interaction of park resources, visitors, and elk. One park operations issue related to elk and vegetation management was identified during internal and public scoping:

Funding and budget constraints continue to reduce the amount of park staff available for elk and vegetation management activities, crowd management (especially related to the elk rut season), and interpretation.

Assumptions

Operations such as lethal reduction, herding, or hazing may decrease densities, but population concentrations in present locations would continue. Meadow area closures and patrols would still be needed, especially during the elk rut season.

Good public education would be needed to inform and educate the public to help reduce negative public perceptions based on misinformation of the management action that is selected.

Visitation increases in the fall due to the elk rut.

Wolves would attract additional visitors.

Implementation of any of the action alternatives would require additional NPS staff and authorized agents of the National Park Service for lethal reduction (culling) activities as defined in Appendix H to accomplish the work.

Fences installed in the first year of the plan would remain in place until vegetation is recovered.

Some fence material would be transported to locations where fences would be constructed using helicopter support, following minimum tool analysis for sites in wilderness. Phased willow fencing coinciding with elk reductions would mitigate the potential for elk to move to town in a single migration in response to loss of habitat.

Phased fence installation could allow fences to be placed in select areas to mitigate impact on visitors.

Assessment Methods

Potential impacts on park operations, including staffing and funding needs, are assessed in relationship to the degree to which elk and vegetation management would change compared to existing management of these resources. Impacts on park operations were evaluated using the process described in the "General Methodology for Establishing Impacts Thresholds and Measuring Effects by Resource" section of this chapter. Information regarding park operations and staffing projections, as well as records used in this analysis, were obtained from the staff at Rocky Mountain National Park. The primary activities for which impacts were anticipated include elk and vegetation management activities, crowd management, and education/interpretation. The steps for assessing impacts included 1) identifying existing responsibilities and routine tasks of the park staff divisions that may be affected by elk and vegetation management actions, 2) determining the potential changes in staff duties or the need for additional staff and funding that would be caused by actions under each alternative, and 3) identifying the impacts of potential constraints in staffing.

Impact Threshold Definitions

Intensity of Impacts

The following thresholds were used to determine the magnitude of effects on park operations:

Negligible: Park operations would not be affected, or the effect would not be noticeable or measurable outside normal variability.

Minor: The effect on park operations would be measurable and might be noticed by park staff, but probably would not be noted by visitors.

Moderate: The effects on park operations would result in a substantial change in park operations and would be noticeable to park staff, but would probably not be noted by visitors.

Major: The effects on park operations would result in a substantial change in park operations and would be noticeable to both park staff and visitors. Staff and visitors would recognize the change as being quite different from existing operations.

Type and Duration of Impacts

Adverse effects would create additional disruptions to park operations or would increase the duties associated with elk and vegetation management.

Beneficial effects would reduce disruptions to park operations, or maintain (or potentially reduce) the duties related to elk and vegetation management.

Duration: Short-term effects on park operations would not extend beyond the first four years of the plan or would be intermittent and directly associated with the management activity being undertaken. Long-term effects on park operations would be continuous over the life of the plan, following the end of the management activity.

Alternative 1

Reduction Activities

Elk would continue to be lethally removed if they exhibit aggressive behavior or show clinical signs of chronic wasting disease. Carcasses would be tested for the presence of chronic wasting disease. The level of staff effort to address chronic wasting disease would continue at a rate similar to current conditions. No specialized funding would be available for chronic wasting disease in the fiscal years which this plan would be implemented.

Visitor Management

Park staff (primarily law enforcement rangers) would continue to address elk-human conflicts as the distribution of the elk population changes and affects different geographic areas. This staff would continue to manage visitors and control traffic. The law enforcement and interpretive rangers would continue to control the flow of traffic and disperse elk from areas where they congregate, with help from the Elk Bugle Corps volunteers. In the summer season, the park employs approximately 35 law enforcement rangers (Ronca 2005a). The activity of visitors watching wildlife would not measurably change, nor would the likelihood of elk-human conflicts (other than what would be attributed to visitation growth).

Fencing

Fencing inside the park is maintained only for vegetation restoration research purposes. Research exclosures cover approximately 12 acres (Ronca 2004). As long as these exclosures are needed they would be maintained

Willows and aspen in core winter range would not be further protected and would continue to become degraded. No measures would be employed to restore over-browsed vegetative areas. The ban on burning in upland shrub, aspen, and willow would continue. Staff would continue to use small amounts of fencing in some localized, developed areas when needed. This use of fencing would not exceed the regular duties of park staff.

Monitoring

Monitoring for elk population and distribution, chronic wasting disease, and surveillance would continue. Monitoring of the elk population and distribution would continue to be conducted both inside and outside the park. No changes would be expected of the methodology used, team size required, or frequency of this activity. Monitoring for animals infected with chronic wasting disease within the park would continue to occur year round. Fiscal year 2007 would be the last year of specialized funding for chronic wasting disease management. This would be a reduction of approximately $150,000 annually (approximately $10,000 used for chronic wasting disease management in elk) over funding from 2003-2007. It is expected that existing staff would absorb chronic wasting disease response activities at reduced levels.

The ongoing elk and vegetation management and monitoring activities would continue to create long-term, negligible, adverse effects on park operations.

Herding

The occasional herding of elk from the park's campgrounds or from areas where they create traffic problems would occur to disperse crowds of visitors watching them. This typically occurs when many elk congregate in a meadow or other easily visible area, causing onlookers to block traffic in the roadway. This activity would continue to be more frequent during the elk rut, when many visitors come to the park for the express reason of viewing the rut. This increase in traffic and crowd management would not exceed the typical amount for park staff.

Education and Interpretation

The interpretive staff would continue to create publications with information on the elk and their habitat, while interpretive programs would continue to address the elk and vegetation issues at the park to a limited degree. Interpretive programs would focus solely on elk only during the rut season in the program "Elk Echoes" and in some printed media. Degradation would continue in vegetation in areas where high numbers of elk congregate. The updating of interpretive documents would continue to occur as needed to reflect the condition of the elk population and vegetative habitat. This would be within the scope of typical daily and seasonal duties. Natural resource staff would continue to conduct outreach programs for various local groups and would incorporate this information in their presentations as well. The Lyceum series would continue to offer presentations on the elk population and habitat conditions, as they change.

Interpretive Division staff would continue to manage the Elk Bugle Corps, a volunteer group assisting the park rangers who provide interpretation to visitors during the elk rut. Under Alternative 1, these volunteers would continue to patrol the areas where elk congregate, control traffic, manage crowds, and educate the public about the natural history of the elk population. This volunteer contribution eases the burden on park staff to manage the events. No change would be expected in the number of volunteers needed, duties performed, or the amount of hours volunteered. The updating of educational material and management of the Elk Bugle Corps

would not measurably differ from this staff's regular duties, and therefore would result in long-term, negligible, adverse effects on park operations.

Cumulative Impacts

Park staff from all divisions would implement existing and future plans and actions throughout the park while operating the park and protecting its resources. Park staff would continue to implement any plan or project within the park. These plans and actions, if successful, would result in better-managed resources and improved effectiveness of park staff over the long-term. However, the requirements on park staff for implementing resource management plans, infrastructure and construction projects, and administrative duties to manage contractors currently exceed the park's available staff level. This parkwide condition would continue to result in long-term, minor to moderate, adverse effects on park operations.

The Resource Management and Research Division staff organizes and conducts the monitoring and management actions such as exotic plant management, prescribed burns, and population and chronic wasting disease monitoring of wildlife. Fire management and fuels reduction activities throughout the park and dissemination of information to the public about the role of fire and the use of safe prescribed burning require a substantial commitment of staff and resources. Population monitoring of other wildlife and vegetation (such as mule deer and boreal toads) is conducted annually. The live testing and removal of mule deer infected with chronic wasting disease is conducted throughout the year by the same staff that remove elk suspected of being infected with chronic wasting disease. This program is scheduled to end prior to or in the initial years in which this plan is implemented. The public would not likely notice any changes in park staff duties, but park staff would be aware of any fluctuations in duties related to these projects and actions. Therefore, the ongoing staff and resource commitment for these resource management efforts represents a long-term, minor, adverse effect on park operations.

Park staff are also increasingly needed for additional visitor and traffic management in popular corridors of the park. A transportation management plan is currently investigating alternative means of managing visitor use, potentially including expanded shuttle bus service to reduce traffic congestion. The reduced traffic control duties for park staff would alleviate the strain on the already overextended Resource Protection Division staff and would result in a long-term, minor, beneficial effect.

Implementation of these past, ongoing, and future plans and actions all represent increased duties for the park staff. These tasks combine to have long-term, minor-to-moderate, adverse effects on park operations. Alternative 1 would contribute long-term, negligible, adverse effects on park operations due to continued monitoring and resource management tasks and updating of park interpretive media. Cumulatively, Alternative 1 with the other projects and actions would have long-term, minor-to-moderate, adverse effects on park operations.

Conclusion

Under Alternative 1, reduction activities would continue to occur only when elk are suspected of having contracted chronic wasting disease. Visitation would have no measurable change and cause no increase in the traffic or crowd control required. Vegetation exclosures in the park are no longer actively researched, and their maintenance would have no effect on park operations. The ongoing monitoring and management activities throughout the park would create long-term, negligible, adverse effects. Park staff would continue to update media regularly with the condition of the elk population and its habitat, and no measurable change would occur in the management of volunteers, resulting in long-term, negligible, adverse effects on park operations.

Cumulatively, Alternative 1, with the other projects and actions, would have long-term, minor-to-moderate, adverse effects on park operations.

Alternative 2

Reduction Activities

Under this alternative, NPS staff and their authorized agents would use high-intensity lethal reduction to achieve population targets. This would involve the reduction of 200 to 700 elk per year for first four years, followed by 25 to 150 per year over the next 16 years. Lethal reduction activities would be primarily conducted by contractors in the first four years of the plan, when lethal reduction efforts would be the most intense. In years 5 through 16, NPS staff and their authorized agents would have to be certified in firearms training, specially trained in wildlife culling, and be required to pass a proficiency test in order to qualify to participate in lethal reduction (culling) activities. If NPS staff would conduct lethal reduction, this would include NPS range qualification at the intensity and frequency required for law enforcement rangers. The removal of carcasses would be done by NPS staff and their authorized agents on foot or with a horse, all-terrain vehicle, truck, or helicopter in remote locations if necessary due disease management concerns , following a minimum tool analysis for areas in recommended or designated wilderness.

If necessary, a temporary capture facility, where the park staff and their authorized agents would administer the lethal measures, would be constructed to rapidly meet population objectives. The added tasks related to construction and teardown of the capture facility would be accomplished by new NPS staff or contractors and result in short-term, negligible-to-minor, adverse impacts on park operations.

The logistical and operational changes involved in the lethal reduction by new staff or authorized agents would result in short-term, minor-to-moderate, adverse impacts for the first four years, declining to short term and minor for the remainder of the plan.

Visitor Management

Park staff would continue to mitigate elk-human conflicts, manage traffic, and redistribute the elk from areas where they congregate. The tasks related to elk management and crowd control would be much the same as current conditions, as the presence and location of elk would continue to be a visitor attraction in the fall. Following the initial heavy reduction, there would be fewer elk, but they would still be expected to use highly visible areas. The need for elk management and crowd control would be somewhat less than present in the early part of the plan, but would return to levels equivalent to present in the later years of the plan. Some elk-human conflicts would continue to occur and therefore the need for occasional redistribution would remain, although the elk would be less habituated in general. The resulting beneficial effects would be short term and long term and of minor intensity. During lethal reduction activities, the increased need for visitor control would result in a short-term, negligible-to-minor, adverse impact on park operations. This may include management of individuals or groups who would choose to protest the lethal reduction activities.

Fencing

Under this alternative, the park staff would manage a contractor who would install fencing around aspen (up to 160 acres) on the primary winter and summer elk range. Park staff would be

responsible for the maintenance of this fencing. Existing fencing surrounding the research exclosures would continue to be maintained. The added tasks related to fencing would be accomplished by existing park staff supplemented by new staff or by contractors and would result in short- and long-term, minor, adverse impacts on park operations.

Monitoring

Resource management staff would conduct monitoring at an increased level of intensity for elk population, demographics, and distribution, chronic wasting disease prevalence, and conditions of willow, aspen, herbaceous vegetation, and beaver. Monitoring the overall visitor experience would be altered in content and increased in intensity to assess the visitor response to elk and vegetation management activities. Monitoring chronic wasting disease would greatly increase because there would be many carcasses available during a short period of time due to the heavy lethal reduction. This would occur primarily in winter. The increased monitoring activities would be conducted by existing park staff supplemented by new staff or by contractors. The tasks and allocation of resources related to monitoring activities would create long-term, minor to moderate, adverse effects on park.

Redistribution Techniques

During lethal reduction activities, unsuppressed weapons could also be used to distribute the elk. Redistribution techniques would be conducted throughout the year, as needed, to disperse elk from sensitive areas in the park or to move aggressive elk.

Trained herding dogs, riders on horseback, staff members using noisemakers or visual devices, or helicopters as an adaptive tool would be used to herd elk from the primary winter range to the primary summer range or, if needed, into a capture facility. Redistribution activities would be conducted by existing park staff supplemented by new staff or by contractors. Redistribution activities may be needed more frequently in the last 16 years because less lethal reduction would be occurring. Redistribution techniques would have a long-term, minor-to-moderate, adverse effect on park operations.

Prescribed Fire

Fuels control and prescribed burn vegetation management for willow and aspen would be conducted by park staff to help restore the condition of these vegetative communities, if needed. Since no restoration of these species is currently undertaken, these efforts would result in an increase in regular staff duties. Effects on park operations due to the increased tasks for prescribed burning would be short term, minor, and adverse.

Education and Interpretation

Under Alternative 2, park staff would develop and disseminate information and educational materials regarding elk and vegetation management activities. This would include interpretation, literature and brochures, a plan-specific Website, and outreach programs intended to increase public understanding of the management actions taking place, safety risks, and the role of the elk in the environment. Initial development of new interpretive and educational media would result in a short-term, minor-to-moderate, adverse effect on park operations in the early period of plan implementation.

The Interpretation Division manages the Elk Bugle Corps. Under this alternative, the Elk Bugle Corps would still operate in the same manner as they have in the past because elk would still be readily visible in open areas. However, there would be fewer elk that are less habituated and less concentrated, but high numbers of visitors would still be expected to observe fall rut.

Research Activities

A three-year research study evaluating procedures for a live test for chronic wasting disease in elk and efficacy of a fertility control agent would be conducted in coordination with elk management activities in the first three years of the plan. As this study would be not be conducted by park staff and would opportunistically use elk that are subject to elk management actions, there would be a negligible adverse effect on park operations to those described above.

Cumulative Impacts

Effects on park operations from the ongoing condition of increasing duties for understaffed divisions, as well as the implementation of other plans and actions, would be the same as described under Alternative 1: long term, minor to moderate, and adverse. Alternative 2 would involve a large effort by park staff in the early years of the plan for establishing the lethal reduction and vegetation restoration program, constructing fencing and a capture facility, if needed, managing visitors during lethal reduction, developing new park media, and managing and performing the initial high-intensity lethal reduction activities. Over time, these effects of lethal reduction would diminish, but redistribution, monitoring, education, and fence maintenance would continue, resulting in long-term, negligible-to-moderate, adverse effects, as less lethal reduction would be necessary and the demands on park staff would return to more normal levels, resulting in long-term, negligible-to-moderate, adverse effects. The high-intensity reduction of elk would also create long-term, negligible-to-minor, beneficial effects from reducing the number of and habituation of elk congregating in the park and requiring management by park staff. Overall, cumulative effects of other plans and actions combined with Alternative 2 would be long-term, minor to moderate, and adverse.

Conclusion

The logistical and operational changes involved in the lethal reduction would result in short-term, minor-to-moderate, adverse impacts for the first four years, declining to short-term and minor for the remainder of the plan. The added tasks related to the capture facility would result in short-term, negligible-to-minor, adverse impacts on park operations. The decreased need for managing elk/human conflicts would result in short- and long-term, minor, beneficial effects. During lethal reduction activities, the increased need for visitor control would result in short-term, negligible-to-minor, adverse effects. The added tasks related to fence installation would result in short- and long-term, minor, adverse effects on park operations. The tasks and allocation of resources related to continued monitoring activities would create long-term, minor to moderate, adverse. Redistribution techniques would have a long-term, minor-to-moderate, adverse effect. Increased prescribed burning would have short-term, minor, adverse effects. The initial development of new interpretive and educational media would result in a short-term, minor-to-moderate, adverse effect on park operations in the early period of plan implementation. Implementation of a three-year research study to evaluate chronic wasting disease testing procedures in a free-ranging population in concert with elk management activities would result in a negligible adverse effect.

Cumulative effects of other plans and actions combined with Alternative 2 would be long-term, minor to moderate, and adverse.

Alternative 3

Reduction Activities

Under this alternative, park staff and their authorized agents would conduct low-intensity lethal reduction of elk to achieve moderate population reduction. The operational changes involved in achieving the lower levels of lethal reduction would be similar to those described for the last 16 years of the plan in Alternative 2. The adverse effect on park operations would be short-term and minor.

Visitor Management

The effects of managing visitors and traffic would be similar to those described in Alternative 2. Park staff would continue to mitigate elk-human conflicts, manage traffic, and redistribute the elk from areas where they congregate. Because of the higher elk population target under this alternative, the frequency of park actions to manage visitors would be higher than Alternative 2. Management actions to reduce and redistribute the elk population would result in elk being less habituated in general. The resulting beneficial effects would be short term and long term and of minor intensity. During lethal reduction activities, the increased need for visitor control would result in a short-term, negligible-to-minor, adverse impact on park operations, although it would occur less frequently than in Alternative 2. This may include management of individuals or groups who would choose to protest the lethal reduction activities.

Fencing

The National Park Service would manage a contractors who would install fencing around aspen and willow (up to 600 acres) on the primary winter and summer elk ranges. Park staff would be responsible for maintaining this fencing. The increased installation and maintenance of fences would be accomplished by existing park staff supplemented by new staff or by contractors and would result in short- and long-term, minor-to-moderate, adverse effects on park operations.

Monitoring

The park staff would conduct increased vegetation monitoring activities, which would be at a similar level of intensity as described in Alternative 2 and impacts would be the same as under Alternative 2: long-term, adverse, and minor to moderate.

Redistribution Techniques

Redistribution techniques and their effects would be the same as described in Alternative 2. Due to the less intense lethal reduction and less effective distribution of elk, redistribution techniques would be used to a greater extent in the early years of the plan to protect sensitive vegetative habitat. The higher numbers of elk would likely congregate in higher concentrations in unfenced areas and would therefore require more redistribution. If redistribution techniques were successful and conducted over the long-term, the activity by staff to continually displace elk would result in long-term, moderate, adverse effects on park operations.

Prescribed Fire

Since reduction of elk would be slower in this alternative, prescribed fire activities would occur sooner in fenced areas to stimulate growth of sensitive vegetation. The increased prescribed fire activities conducted by park staff would create short-term, negligible-to-minor, adverse effects on park operations.

Education and Interpretation

The tasks involved in the development of updated interpretive and educational information and the effects of these efforts on park staff would be the same as described in Alternative 2.

Research Activities

A three-year research study evaluating procedures for a live test for chronic wasting disease in elk and efficacy of a fertility control agent would be conducted in coordination with elk management activities in the first three years of the plan. As this study would not be conducted be park staff and would opportunistically use elk that are subject to elk management actions, there would be a negligible adverse effect on park operations to those described above.

Cumulative Impacts

Cumulative effects of other plans and actions would be the same as described for Alternative 1: long term, minor to moderate, and adverse. Alternative 3 would have effects related to the annual lethal reduction of up to 200 elk that remain consistent throughout the life of the plan. The program establishment and lethal reduction activities, vegetation restoration activities, visitor management during lethal reduction activities, and redistribution of elk would result in long-term, negligible-to-moderate, adverse effects. Beneficial effects of reducing the elk population and, consequently, the park operations related to their management, would be both short- and long-term and of minor intensity. However, fencing, redistribution techniques, and prescribed burning would be used extensively for vegetation protection in this alternative to compensate for the slower reduction of the elk population. Overall, the cumulative effects of other plans and actions combined with Alternative 3 would be long term, minor to moderate, and adverse.

Conclusion

The operational changes involved in the lethal reduction would result in short-term, minor-to-moderate, adverse effects over the life of the plan. The beneficial effects of reduced elk-human conflicts would be short- and long-term and of minor intensity, although these effects would occur incrementally over the life of the plan. During lethal reduction activities, the increased need for visitor control would result in short-term, negligible to minor, adverse effects. The increased installation and maintenance of fences would result in short- and long-term, minor-to-moderate, adverse effects. The tasks and related monitoring activities would create long-term, minor to moderate, adverse effects. The use of redistribution techniques would result in long-term, moderate, adverse effects on park operations. The increased prescribed fire activities that would be conducted would create short-term, minor, adverse effects on park operations. Developing new interpretive and educational media would result in a short-term, minor to moderate, adverse effect on park operations in the early period of plan implementation. Implementation of a three-year research study to evaluate chronic wasting disease testing procedures and fertility control drug effectiveness in a free-ranging population in concert with elk management activities would result in a negligible adverse effect.

The cumulative effects of other plans and actions combined with Alternative 3 would be long term, minor to moderate, and adverse.

Alternative 4

Reduction Activities

Alternative 4 would include a combination of fertility control and lethal reduction of 80 to 150 elk per year over the 20-year life of the plan. Park staff or contractors would administer a fertility control agent by remotely darting and marking the cow elk or by hand injection. Lethal reduction would supplement the use of fertility control agents. Use of lethal reduction would decrease in the later years of the plan as the fertility control agent becomes more effective and there is increased technology to managing the population. Ongoing lethal reduction, fertility control, carcass removal, and chronic wasting disease testing activities by the staff and contractors would represent additional tasks for the resource management staff, resulting in long-term, minor-to-moderate, adverse effects.

Hand injection would require capture and handling of elk, and one temporary capture facility would be constructed if this method were necessary. This would require the park staff to construct and tear down the facility. Administering the drug by hand at a temporary capture facility would considerably increase the workload for resource management staff. The labor involved in the construction, use, and tear-down of a temporary capture facility would result in a short-term, minor, adverse effect.

Visitor Management

The effects of managing visitors would be the same as described in Alternative 3.

Fencing

Fencing of aspen on the winter and summer elk range and montane riparian willow communities on the core winter range, and the effects of these actions on park operations, would be the same as described for Alternative 3.

Monitoring

The park staff would conduct increased vegetation monitoring activities, which would be at a similar level of intensity as described in Alternative 2 and impacts would be the same as under Alternative 2: long-term, adverse, and minor to moderate.

Redistribution Techniques

Redistribution techniques would be conducted in the same manner as described in Alternative 2. Due to the less intense lethal reduction and less effective distribution of elk, they would congregate in higher concentrations in unfenced areas.

Herding activities would be conducted in the same manner as described in Alternative 3. If a temporary capture facility were used, park staff would use herding techniques to move the elk into the facility. It is estimated that herding would require the labor of three full-time-equivalent employees annually. Effects on park operations resulting from redistribution techniques would be the same as described for Alternative 3.

Prescribed Fire

The increased prescribed fire activities that would be conducted as a result of the slower reduction of elk in this alternative would have the same effects on park operations as described for Alternative 3.

Education and Interpretation

The tasks involved in the development of updated interpretive and educational information and the effects of these efforts would be the same as described in Alternative 2. Special media would be prepared for hunters in the areas outside the national park (Game Management Units 18, 19, and 20, and other units as needed) to give detailed information on the safety of consuming the meat of elk that have been treated with fertility control agents.

Research Activities

A three-year research study evaluating procedures for a live test for chronic wasting disease in elk and efficacy of a fertility control agent would be conducted in coordination with elk management activities in the first three years of the plan. As this study would not be conducted be park staff and would opportunistically use elk that are subject to elk management actions, there would be a negligible adverse effect on park operations to those described above.

Cumulative Impacts

Cumulative effects of other plans and actions would be the same as described for Alternative 1: long-term, minor to moderate, and adverse. Alternative 4 would involve increasing staff duties for the administration of fertility control agents, as lethal reduction activities would decrease over the life of the plan to augment the fertility control. Additional duties for park staff would be higher if a capture facility was built and the fertility control agent was hand administered. The program establishment, fertility control and lethal reduction activities, vegetation restoration activities, visitor management during lethal reduction activities, and redistribution of elk would result in long-term, negligible-to-moderate, adverse effects.

Some short-term adverse effects would occur due to the labor involved in program implementation, but these would be offset with the higher number of lethally removed animals in the later years of the plan. Beneficial effects of reducing the elk population and, consequently, the park operations related to their management would be short- and long-term and minor. Overall, the cumulative effects of other plans and actions combined with Alternative 4 would be long term, minor to moderate, and adverse.

Conclusion

Lethal reduction and fertility control activities and the removal of carcasses would result in long-term, minor-to-moderate, adverse effects on park operations. The labor involved in the construction and teardown of a temporary capture facility would result in a short-term, minor, adverse effect. The decreased need for traffic and crowd control would result in long-term, minor, beneficial effects. During lethal reduction activities, the increased need for visitor control would result in short-term, minor, adverse effects. The increased installation and maintenance of fences would result in short- and long-term, minor-to-moderate, adverse effects. The tasks and related monitoring activities would create long-term, minor-to-moderate, adverse effects. Redistribution techniques would result in long-term, moderate, adverse effects. The increased

prescribed fire activities that would be conducted would create short-term, minor, adverse effects. Developing new interpretive and educational media would result in a short-term, minor to moderate, adverse effect on park operations in the first years of the plan. Implementation of a three-year research study to evaluate chronic wasting disease testing procedures and fertility control drug effectiveness in a free-ranging population in concert with elk management activities would result in a negligible adverse effect.

The cumulative effects of other plans and actions combined with Alternative 4 would be long term, minor to moderate, and adverse.

Alternative 5

Reduction Activities

Under this alternative, reduction and distribution of the elk population would be accomplished in part by the release of wolves in the park. A contractor would likely be responsible for most tasks required for implementing the release and monitoring program, including the construction of facilities and obtaining wolves from another location. NPS staff would be responsible for administering the program and coordinating activities with the contractor. Some NPS staff would intermittently assist the contractor with tasks or activities, such as installing the wolf acclimation pen. This would result in short-term, negligible-to-minor, adverse effects on park operations.

The reduction of the elk population by wolves would be supplemented with lethal control activities. This would involve the same methods and short-term effects as described in Alternative 2, including a temporary capture facility if needed for lethal reduction. The use of lethal reduction would decrease over time if the activities of wolves were successful in distributing and reducing elk numbers. The overall impact intensity would be the same as in Alternative 2.

Visitor Management

Elk-human conflicts and the need for traffic and crowd control would gradually decline over the life of the plan. Effects on park operations would be similar to those under Alternative 2. Wolves and the potential to see wolves would be a substantial attraction for visitors. When wolves are sighted, visitors would be expected to stop and congregate on road sides. This would be similar to the effects of elk viewing. This would result in the need to manage visitors that gather when wolves are visible. This would result in a short-term, minor, adverse effect on park operations.

Fencing

The extent of fencing, labor, and effects of installing and maintaining it would be the same as described for Alternative 2.

Monitoring

Under this alternative, the monitoring of elk and vegetation management activities would be the same as described under Alternative 2. The monitoring of chronic wasting disease from lethal reduction activities would be less than Alternative 2 because the reduction of elk would not be as rapid. Monitoring the chronic wasting disease status of wolf prey items (elk, deer, moose) would increase monitoring intensity. Wolf activity would be monitored and monitoring of visitor

experience would change to assess the impact of the presence of wolves and any problems or perceived benefits of this action. These activities would result in long-term, moderate, adverse effects on park operations.

Redistribution Techniques

Wolves would effectively distribute the elk throughout the park; therefore, no additional redistribution techniques would be used.

Herding, as described in Alternative 2, would be used as necessary by park staff to move elk into a capture facility for lethal reduction. The effects of herding on park operations would be the same as in Alternative 2.

Prescribed Fire

The actions and effects of prescribed fire would be the same as described for Alternative 2.

Education and Interpretation

Development of interpretive programs and information describing the elk and vegetation management activities would be the same as in Alternative 2. New interpretive information and programs would be developed to explain the role of wolves in the ecosystem and safety and wolves. The public and the local community, however, would require a substantial amount of information, education, and outreach to achieve acceptance of wolves. Eight to 20 hours of orientation and training would be required for staff members from all divisions and volunteers including the Elk Bugle Corps (Langdon 2004a). These activities would result in a moderate-to-major, adverse effect, which would be reduced to minor in the long term.

Research Activities

A three-year research study evaluating procedures for a live test for chronic wasting disease in elk would be conducted in coordination with elk management activities in the first three years of the plan. As this study would not be conducted be park staff and would opportunistically use elk that are subject to elk management actions, there would be a negligible adverse effect on park operations to those described above.

Cumulative Impacts

Cumulative effects of other plans and actions would be the same as described for Alternative 1: long-term, minor to moderate, and adverse. Alternative 5 would involve an increase in staff duties for the establishment and management of a wolf program, including intensive monitoring and interpretive duties that would remain fairly consistent over time. The wolf release program, lethal reduction activities, and vegetation restoration activities would result in long-term, negligible to moderate, adverse effects.

Some short-term, adverse effects would result from supplementing the effort with lethal reduction activities, the management of visitors viewing the wolves, and construction of a acclimation pen; however, these effects would be intermittent. The cumulative effects of other plans and actions combined with Alternative 5 would be long term, minor to moderate, and adverse.

Conclusion

The release and monitoring of wolves would result in short-term, negligible-to-minor, adverse effects on park operations. The lethal reduction activities would result in minor-to-moderate, adverse effects in the short-term, but decline to short-term and minor for the remainder of the plan if wolves were successful. The added tasks related to the capture facility would result in short-term, negligible-to-minor, adverse effects on park operations. Elk-human conflicts would decrease in the park, but the need for traffic and crowd control would slightly increase over time due to the viewing of wolves, resulting in short-term, minor, adverse effects. The added tasks related to fence installation would result in short- and long-term, negligible, adverse effects on park operations. The tasks and related monitoring activities including increased monitoring of wolf activity and visitor response to wolves would create long-term, moderate, adverse effects. Herding to a capture facility would have a long-term, minor, adverse effect. Prescribed fire would have short-term, negligible to minor, adverse effects. Information, education, and outreach activities associated with the wolf release program would result in a moderate to major, adverse effect, which would be reduced to minor in the long term. Initial integration of wolves and lethal reduction into interpretive materials would result in a short-term, moderate to major, adverse effect that would reduce to minor in the long-term. Implementation of a three-year research study to evaluate chronic wasting disease testing procedures in a free-ranging population in concert with elk management activities would result in a negligible adverse effect on park operations as a result of the study.

The cumulative effects of other plans and actions, combined with Alternative 5, would be long-term, minor to moderate, and adverse.

SUSTAINABILITY AND LONG-TERM MANAGEMENT

Unavoidable Adverse Impacts

Unavoidable adverse impacts are those environmental consequences of an action that cannot be avoided, either by changing the nature of the action or through mitigation if the action is taken. Therefore, they would remain throughout the duration of the action.

There would be unavoidable impacts under Alternative 1 from the elk population continuing to be of higher density, less migratory, and more habituated to people. Vegetation degradation in the primary winter and summer ranges would continue as a result of high levels of elk herbivory. Wildlife, including species of special concern, would continue to be adversely affected by high elk populations and degraded vegetation. Decreased species richness and diversity would continue, and beaver, small mammal, songbird, waterfowl, and butterfly populations would continue to be depressed and adversely affected. Unavoidable impacts would continue on hydrology as a result of reductions in the activities of beavers and reduced presence of beaver ponds. Reduced soil productivity and nutrient cycling would continue in areas of high elk concentration. Alternatives 2, 3, 4, and 5 would have unavoidable impacts from increased deer populations and adverse effects on upland shrub from increased browsing and increased competition with other wildlife species. Under Alternative 5, wolves would periodically and rapidly disperse elk, sheep, and deer, causing increased stress and energy expenditure by the animals. Coyote populations may decline as a result of competition with wolves.

Unavoidable impacts from Alternatives 2, 3, 4, and 5 would occur on wildlife from human activity in the environment during lethal reduction, redistribution, carcass removal, capture activities, and use of helicopters as an adaptive management tool. These activities would produce noise and visible activity that would have unavoidable adverse impacts on the natural soundscape in the park and on the experience of visitors. The action of reducing elk through lethal methods would have unavoidable adverse effects on people who have ethical concerns about such actions. Park operations would be unavoidably affected by all action alternatives through increased staff activity and logistics associated with all means of elk and vegetation management and monitoring.

Fences would potentially interfere with movement for wildlife species in all action alternatives, especially in Alternatives 3 and 4. The installation and presence of large amounts of fence would have unavoidable adverse effects on and detract from wilderness quality and visitors' experience.

Reduced numbers of elk under Alternatives 2, 3, and 4 would cause reductions in park visitation that would have unavoidable adverse impacts on the regional economy. This would be most evident in Alternative 4 with its use of fertility control methods.

Relationship between Local Short-term Uses of the Environment and the Maintenance and Enhancement of Long-term Productivity

This determination identifies whether the proposed action would trade-off the immediate use of the land or resources for any long-term management possibilities, adversely affecting the productivity of recreation area resources. This determination also discloses whether the proposed action or alternatives would be a sustainable action that could continue over the long term without environmental problems (NPS 2001c).

None of the alternatives suggest substantial loss or impairment of natural resources or ecosystems in the park as a consequence of their implementation. In the short-term, the action alternatives would trade off small areas of land used temporarily for a capture facility or for staging materials and equipment for the construction of fences with the long-term improvements to vegetation and other associated natural resources within elk primary winter and summer ranges.

Irreversible or Irretrievable Commitments of Resources

The intent of this determination is to identify whether the proposed action or alternative would result in effects or impacts that could not be changed over the long term or would be permanent. An effect on a resource would be irreversible if the resource could not be reclaimed, restored, or otherwise returned to conditions that existed before the disturbance. An irretrievable commitment of resources involves the effects on resources that, once gone, cannot be replaced or recovered (NPS 2001c).

All five alternatives would involve the irretrievable commitment of labor and fossil fuels to varying degrees. None of the alternatives would be expected to result in the irreversible or irretrievable commitment of park resources.